No. 3200. Vol. 123. Registered as a Newspaper. THE ARCHITECTS' JOURNAL for June 28, 1956. Price One Shilling.

THE ARCHITECTS' JOURNAL

Domestic Heating

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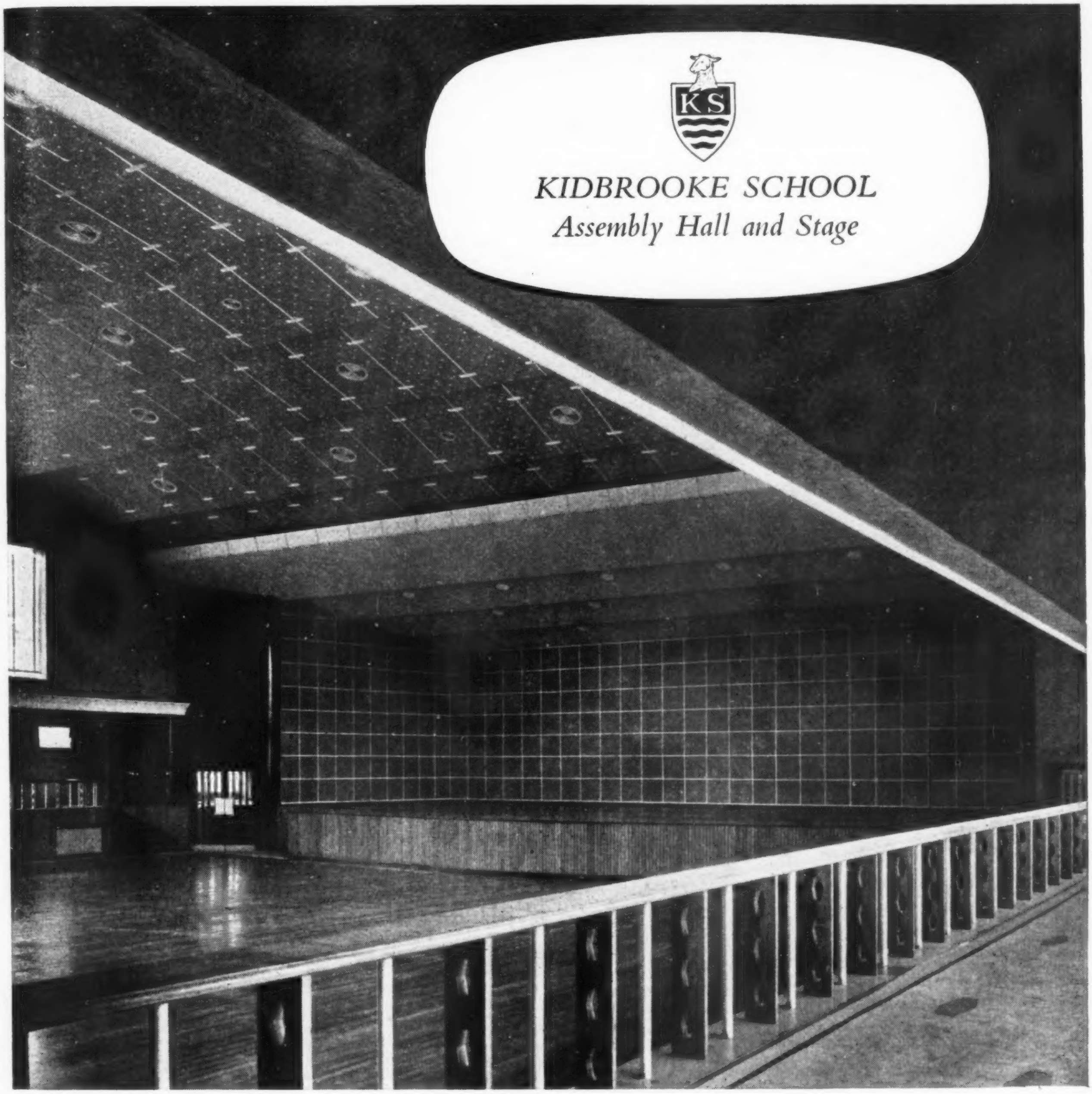
DIFF
UGH
UTH



Architects: Slater, Uren & Pike, F.F.A., A.R.I.B.A. Contractor: Gee, Walker & Slater Ltd.

The restricted choice of colours has long posed a major problem in the age-old art of paint-colour decoration. That Robbialac Colorizer Paints offer an almost limitless freedom in the selection of tints and shades is one of the reasons why these famous Paints are continually being used in bringing added distinction to contemporary buildings throughout the world.

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The Architectural Bureau

of Jenson & Nicholson Ltd., offers a complete colour advisory service to Architects and will, if desired, co-operate with executives and contractors. A brochure on Robbialac Colorizer Paints and their possibilities, especially written for Architects, is available on request.

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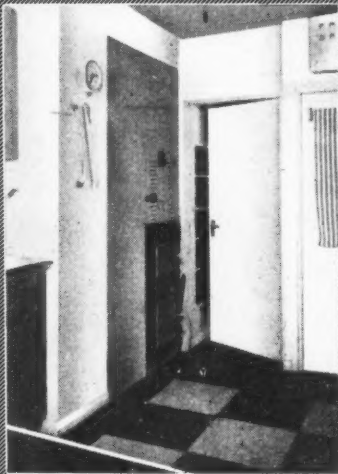
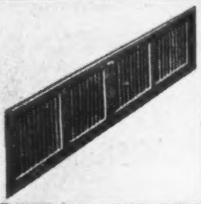
ARCHITECTS CHOOSE RADIATION'S WARM-AIR SYSTEM FOR THEIR HOME

House in Pinner, Mdx. Designed by N. J. Dore, A.R.I.B.A., A.A.Dipl. (Hons.) and T. P. Wurr, A.R.I.B.A., A.A.Dipl.

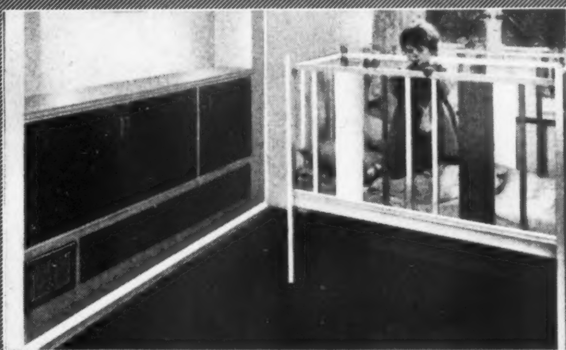


The compact solid fuel unit fits neatly into the kitchen.



Clean, warm air is circulated through these small wall grilles, warming the whole room evenly throughout. No draughts or stuffiness, no dirty stains on the walls.

A perfectly healthy, refreshing warmth is circulated, ideally suited to children, variable to suit the day and hour.



For their new house at Pinner, Middlesex, a husband and wife architect team have specified Radiation's completely automatic Warm-air System. It keeps their open-plan house really warm and comfortable all the year round—with ample hot water whenever it's wanted. Clean warm air is ducted into every room through small, unobtrusive wall grilles. The finger-tip thermostat control adjusts the temperature *exactly* as the occupant wants it.

Whether heated by gas, oil or solid fuel, the Radiation Warm-air System gives maximum comfort at the lowest possible cost in work, fuel and maintenance. In this house the solid fuel heating unit normally requires re-fuelling twice in 24 hours. It burns smokeless fuels—and is virtually smokeless even on bituminous coal.

This installation was designed for a temperature rise of 35°F. throughout the house; and it provides for 50 gal. or more of hot water at 140°F. at the tap in 24 hours—more than enough for baths and general domestic purposes, and to satisfy the very considerable demands of a washing machine.

The house is insulated to the Egerton standard, with extensive single glazing over outside walls. The floor area is 1465 square feet. Consumption of fuel—Phurnacite or coke—was 4 tons 4 cwt. in the first year, 4 tons 8 cwt. in the second year.

Radiation's Warm-air System is the world's most efficient whole house warming method; and it adds substantially to the value of a house.

SMOKELESS WHOLE HOUSE WARMING BY THE

Radiation

WARM-AIR SYSTEM

PIONEERS OF SMOKE REDUCTION

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Corrugated 'Perspex' roof lights in a new British European Airways cargo unit building at London Airport, erected by The Coseley Engineering Co. Ltd., Wolverhampton.

British European Airways use Corrugated 'Perspex' roof lighting

CORRUGATED 'PERSPEX' acrylic sheet is the finest material for roof lighting. Its toughness, durability and high light transmission are unequalled. It will stand up to weather conditions in any part of the world. The properties of Corrugated 'Perspex' are not affected by the corrosive atmospheres in industrial areas.

Corrugated 'Perspex' is very light, easy to handle, and cheap to install. For those rare instances in this country where diffused daylight may be more desirable, Opal 'Perspex' is available. Originally developed for intense light conditions overseas, Opal Corrugated 'Perspex' diffuses daylight evenly and efficiently.

It's as clear as daylight — it must be

Corrugated 'PERSPEX'

'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.

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CP.106

"SCHOOL BUILT IN THIRD OF THE USUAL TIME"

(Extract from the 'Express & Star,' Wolverhampton, August 15th, 1955)

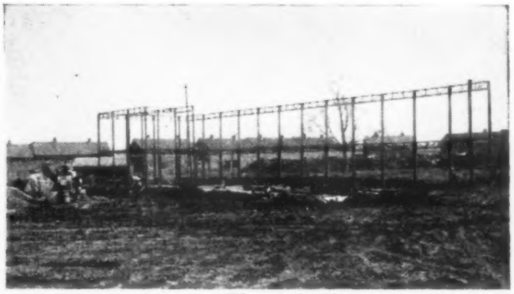
S-P-E-E-D the job with the

THERMAGARD

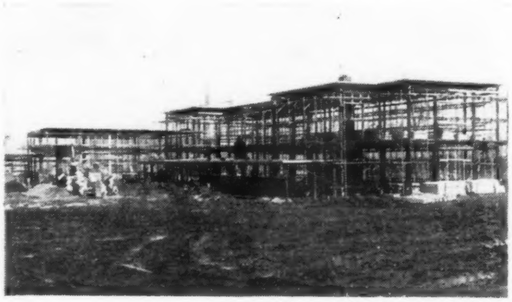
system of constructional steelwork

The potentialities of pre-concrete planning, inherent in the Thermagard modular system, were fully exploited by the County Education Architect, Stafford, A. C. H. Stillman, Esq., F.R.I.B.A., resulting in the Burton Manor County Primary School at Stafford being completed 2 weeks within the scheduled time of 26 weeks.

The site—1st March



The steelwork goes up—1st April



The roof goes on—1st May

The completed school—1st August

G of B

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M-W.B1


Accent on Security
For the safe, sure foothold that only rubber can offer; for its resistance to wear under heavy traffic; for the ease with which it is laid . . . its quietness . . . its permanent good looks, Runnymede Rubber Flooring was chosen for the main Immigration Hall at London Airport where, in the newly-opened South East Face, Passenger Handling Building, an ever-increasing volume of travellers daily arrive from and depart to all parts of the world.
12

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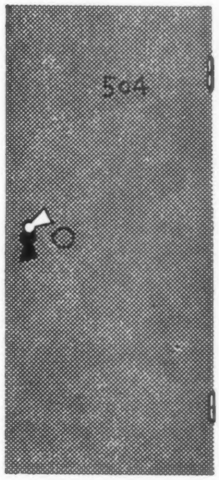
504

Alicanopies

by BAINBRIDGE Bros. (ENGINEERS) Ltd.

BRITISH PATENTS No. 22458/54 & 04972/56
WORLD PATENTS PENDING

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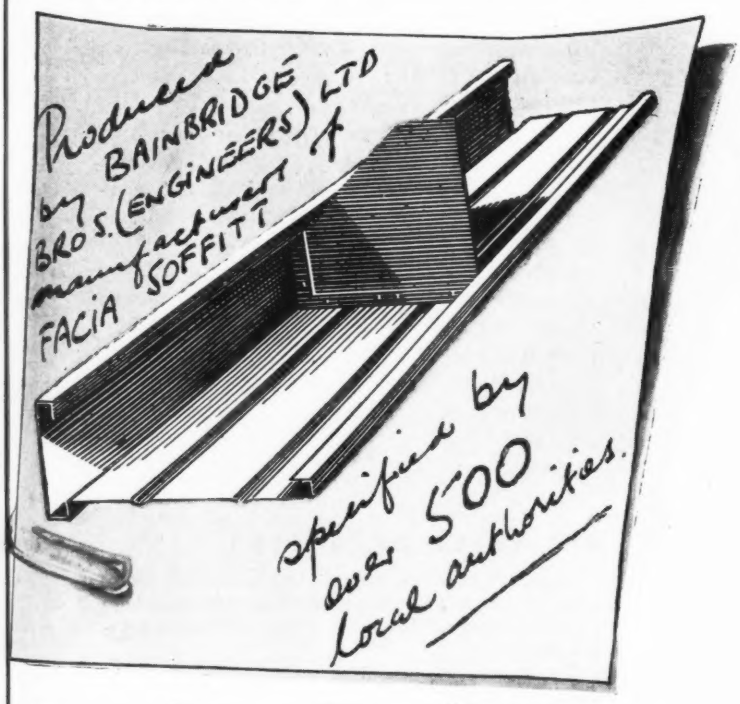
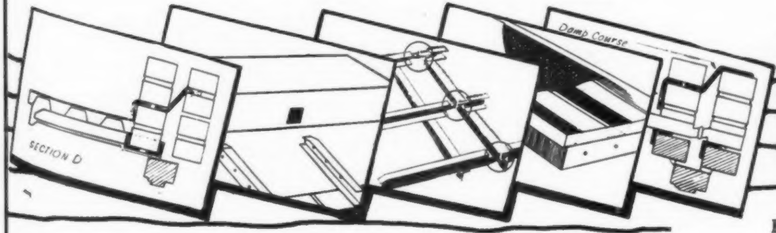
ALICANOPIES are specially designed to give the architect economy and speed in canopy construction, for if these shapes were designed and constructed in other materials in such a way as to require no maintenance other than the periodic painting given to the exterior of the house, the cost would be very considerable. Furthermore, the construction is such that labour for fixing both frame and canopy is cut down to a minimum duration.

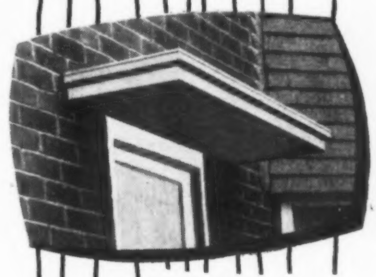




GABLE

GEORGIAN

CONTEMPORARY



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SPRAYED-ON INSULATION

SOLVES MANY PROBLEMS

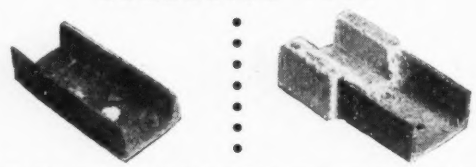
Main Advantages are . . .

- *Combines thermal insulation and sound absorption in one material*
- *Allows intimate surface contact irrespective of shape or protrusions*
- *Provides rot and vermin proof asbestos coating which will withstand vibration*
- *Prevents condensation and consequent corrosion on steel surfaces*

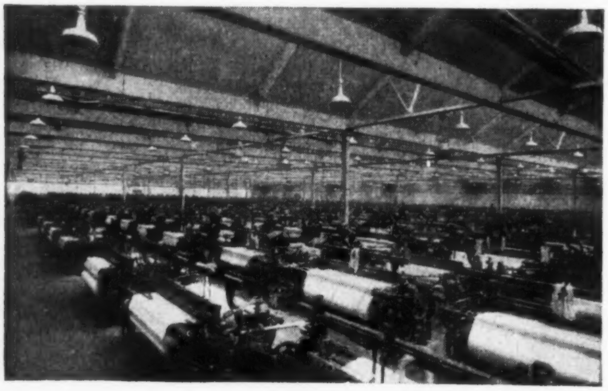
SPRAYED 'LIMPET' (Regd.) ASBESTOS was created to provide a form of thermal and sound insulation with many desirable features in one single operation. The process itself consists of the application, by means of a spray gun, of specially prepared forms of asbestos fibre which are discharged from the main nozzle of the spray gun simultaneously with a spray of water. These thoroughly intermix on leaving the spray gun and firmly adhere to the surface being treated. Irrespective of the shape of the surface, Sprayed 'Limpet' Asbestos completely covers all joints, rivets, or protrusions in one continuous jointless coating, thus eliminating all air spaces with their accompanying disadvantages.

The nature of Sprayed 'Limpet' Asbestos coatings varies with the job in hand, but in all cases it is rot and vermin proof, will not be affected by vibration and for most applications is extremely light in weight. This is the ideal method of combining thermal insulation with sound absorption and admirably suits the needs of various types of auditoria, as well as for the reduction of noise levels in factories, offices and workshops. Full details are contained in our catalogue "Sprayed 'Limpet' Asbestos Insulation", sent on request.

CORROSION TEST



The photograph on the right shows the complete protection offered by Sprayed 'Limpet' Asbestos against corrosion. Both channels were subjected to the same conditions, the test being carried out in a dyeworks.



BIG NOISE REDUCTION

Sprayed 'Limpet' Asbestos has been used in this modern cotton weaving shed to reduce noise and for anti-condensation purposes. Photograph by courtesy of Richard Haworth & Co. Ltd., Hindley Green.

SPRAYED "LIMPET" (Regd.) ASBESTOS BY Newalls

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The most HYGIENIC flooring

One of the most conspicuous advantages of a Clay Quarry floor is that it is so easily kept clean, particularly where skirtings of the same material are used. The smooth, dense surface, free from sharp angles or crevices, may be maintained in a spotless condition by simply sluicing or mopping. Further, floors may be rendered ABSOLUTELY VERMIN-PROOF by the application of colourful Clay Floor Quarries.

They are the obvious choice for all premises where regulations demand washable floors, and for all other buildings where hygienic conditions are essential.

Clay Floor Quarries are highly resistant to impact and abrasion. They are available in a wide range of sizes, thicknesses and shapes, and in uniform shades of red, blue, brown and buff, or in multi-colours, and actually COST LESS THAN ANY OTHER FLOORING MATERIAL

Correctly laid, a Quarry floor will last as long as the building.

For further information, please write to The Secretary, Floor Quarry Association, Federation House, Stoke-on-Trent.

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Every new house needs a "Fortic" (REGD.)

PATENT COMBINATION TANK

★ ECONOMISE ON INSTALLATION COSTS

★ ECONOMISE ON MATERIAL

The "Fortic" Patent Combination tank incorporates a simple, ingenious device which achieves the ideal of a cold water storage compartment completely insulated from the hot water storage compartment in one combined assembly. The FORTIC embodies the patent RANGE BOILER bottom assembly, all brazed seams, special boss connections and the PERMANIZED finish. Fortic tanks are available with or without provision for indirect heating.

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RB 16

Announcement

building products and the Cape Asbestos Group

Asbestolux

Uxbridge Flint Bricks

"Vermiculux" Exfoliated Vermiculite

From July 1, the manufacture and distribution of these products will be the responsibility of a company, which combines the activities of the Uxbridge Flint Brick Company Limited with the Board Division of The Cape Asbestos Company Limited, to be known as

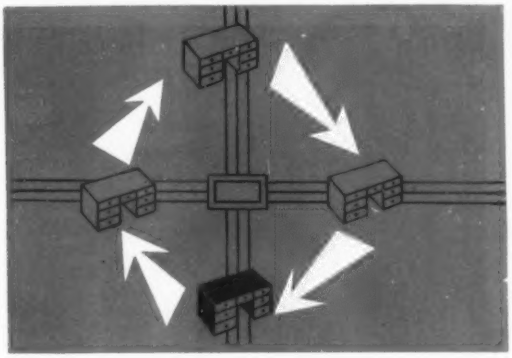
Cape Building Products Ltd.

COWLEY BRIDGE WORKS · UXBRIDGE · MIDDLESEX

Telephone : Uxbridge 4313

The reorganisation is designed to consolidate the development and range of the Group's products in the building field, and assist in improving efficiency and service to architects and contractors, builders merchants and stockists throughout the country.

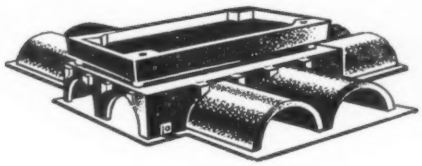
CAPE



KEY UNDERFLOOR DUCTS

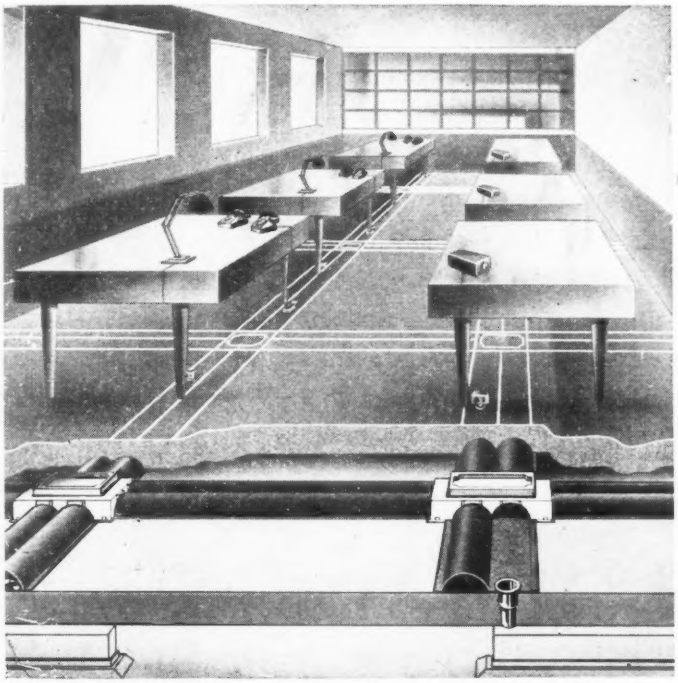
For the internal distribution of light, power and communications

JUNCTION BOXES AND COMPONENTS

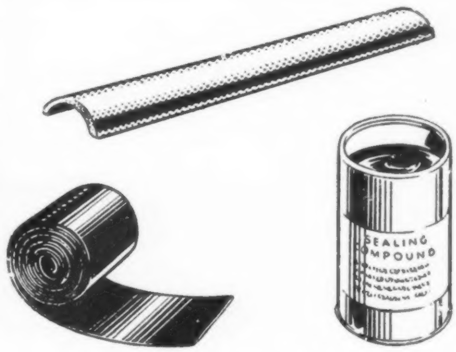


FOR

- ★ *ADAPTABILITY*
- ★ *ECONOMY*
- ★ *PERMANENCE*



A typical arrangement of a twin underfloor duct system showing the inherent adaptability of Key Fibre Underfloor ducts.



We have illustrated above a 2 x 2 and a 3 x 3 Junction Box, together with a section of duct, the sealing compound and impregnated asbestos sheet used in the installation of Key Fibre Underfloor Duct Systems.

KEY ENGINEERING COMPANY LTD KEY Reed

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Also at Trafford Pork, Manchester 17
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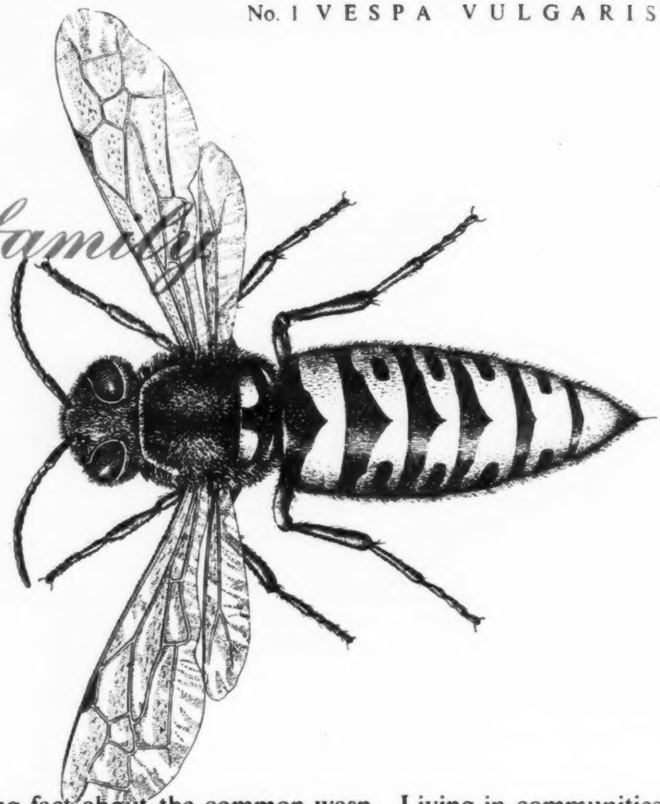
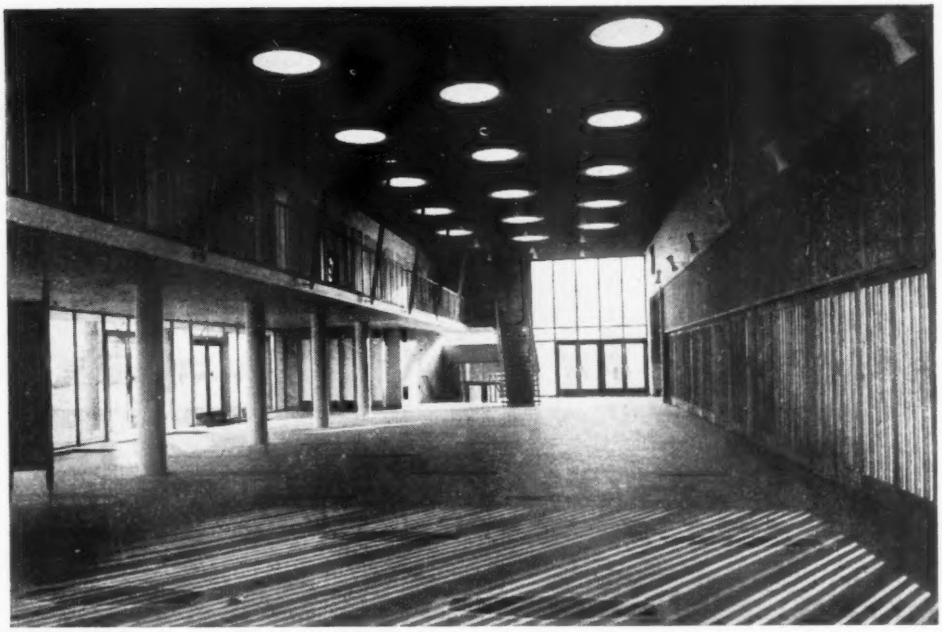
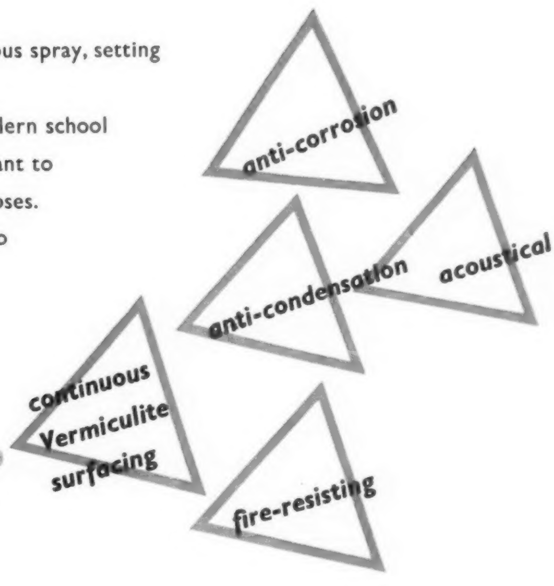




Kidbrooke Comprehensive School —the main entrance hall. Architects: Slater, Uren & Pike, FF./A.R.I.B.A. Pyrok was applied to the ceiling for acoustic and decorative purposes. Pyrok Licensees were C. & T. (Pyrok Contracts) Ltd., London

PYROK in the modern school

Pyrok is a Vermiculite-cement surfacing applied by continuous spray, setting rapidly and adhering strongly to structural steelwork, concrete, stone, brick and fibreboard. Pyrok is used in modern school construction as a decorative and protective surfacing resistant to condensation and fire, also for acoustic and insulating purposes. Pyrok is a process both for interior or exterior use and also a means of carrying out repairs. Contracts are undertaken by Licensees in all parts of the U.K. and in countries abroad. We shall be glad to supply further information on request.



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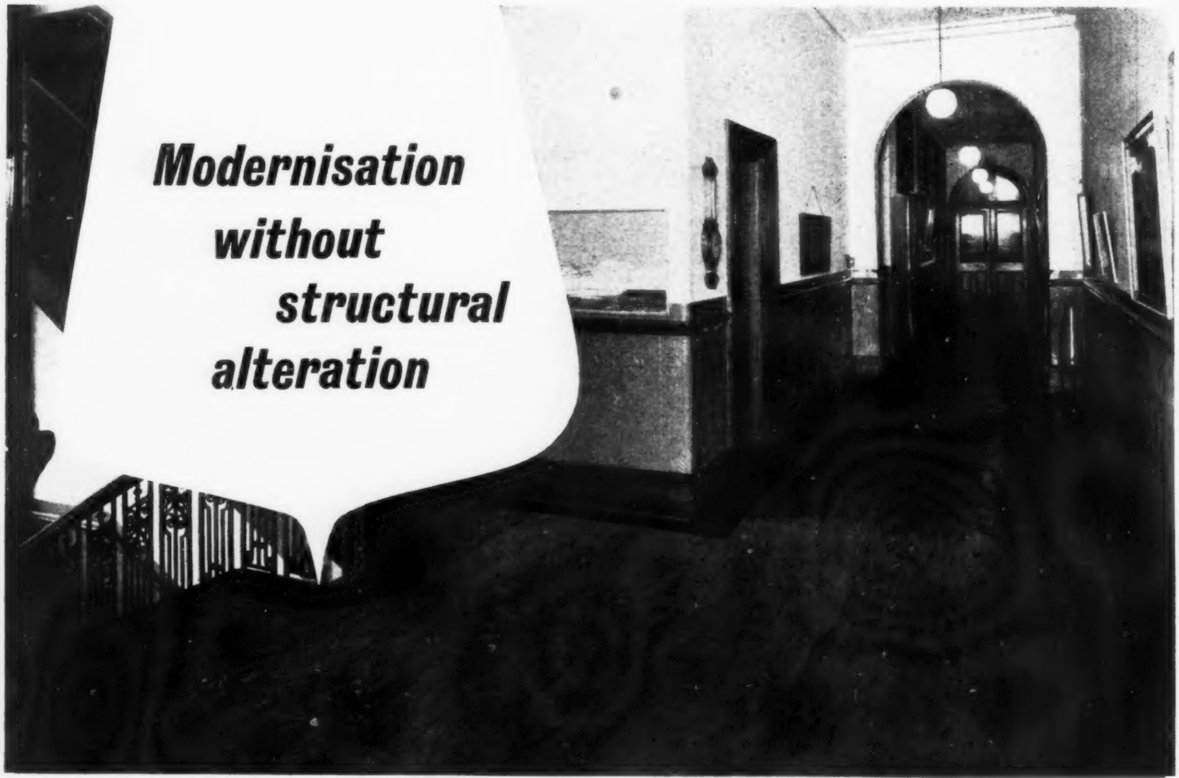

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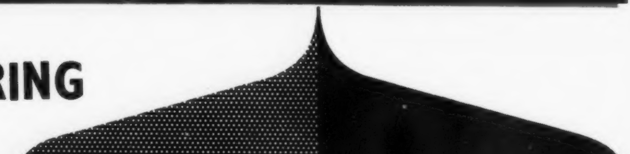
Brings colour, expanse, cohesion

It is the quickest and least expensive way of improving the appearance of an old building.
The two illustrations convey the effect of IOCO Rubber Flooring laid throughout an office block in the North of England.
The work was completed speedily and passages and stairs will maintain their good appearance over many years.
IOCO Rubber Flooring is available in a range of plain and marble colours in various weights.
Samples, prices, etc., on request.



Complete the job with

Vicrtex

For dados, wall panels, couches, etc., Vicrtex vinyl fused fabric brings colour and texture to match, tone or contrast with the flooring. It is the latest decorating inspiration—wipe-clean and practically indestructible. You should know all about it.

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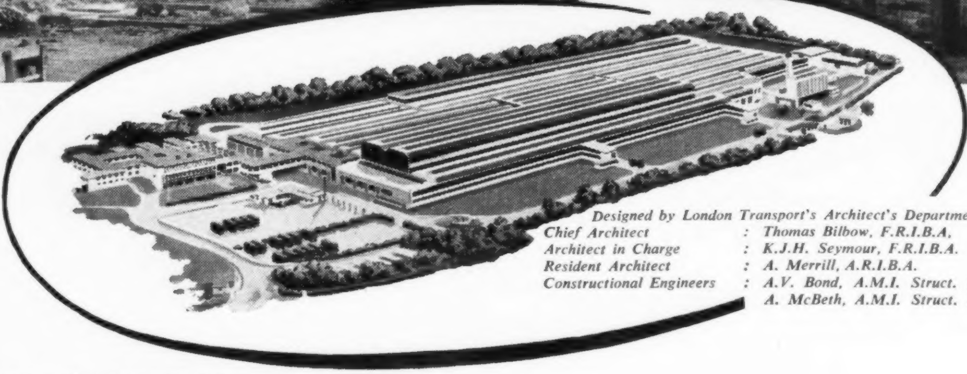

Designed by London Transport's Architect's Department

Chief Architect	*: Thomas Bilbow, F.R.I.B.A.*
Architect in Charge	*: K.J.H. Seymour, F.R.I.B.A.*
Resident Architect	*: A. Merrill, A.R.I.B.A.*
Constructional Engineers	*: A.V. Bond, A.M.I. Struct. E.* *A. McBeth, A.M.I. Struct. E.*

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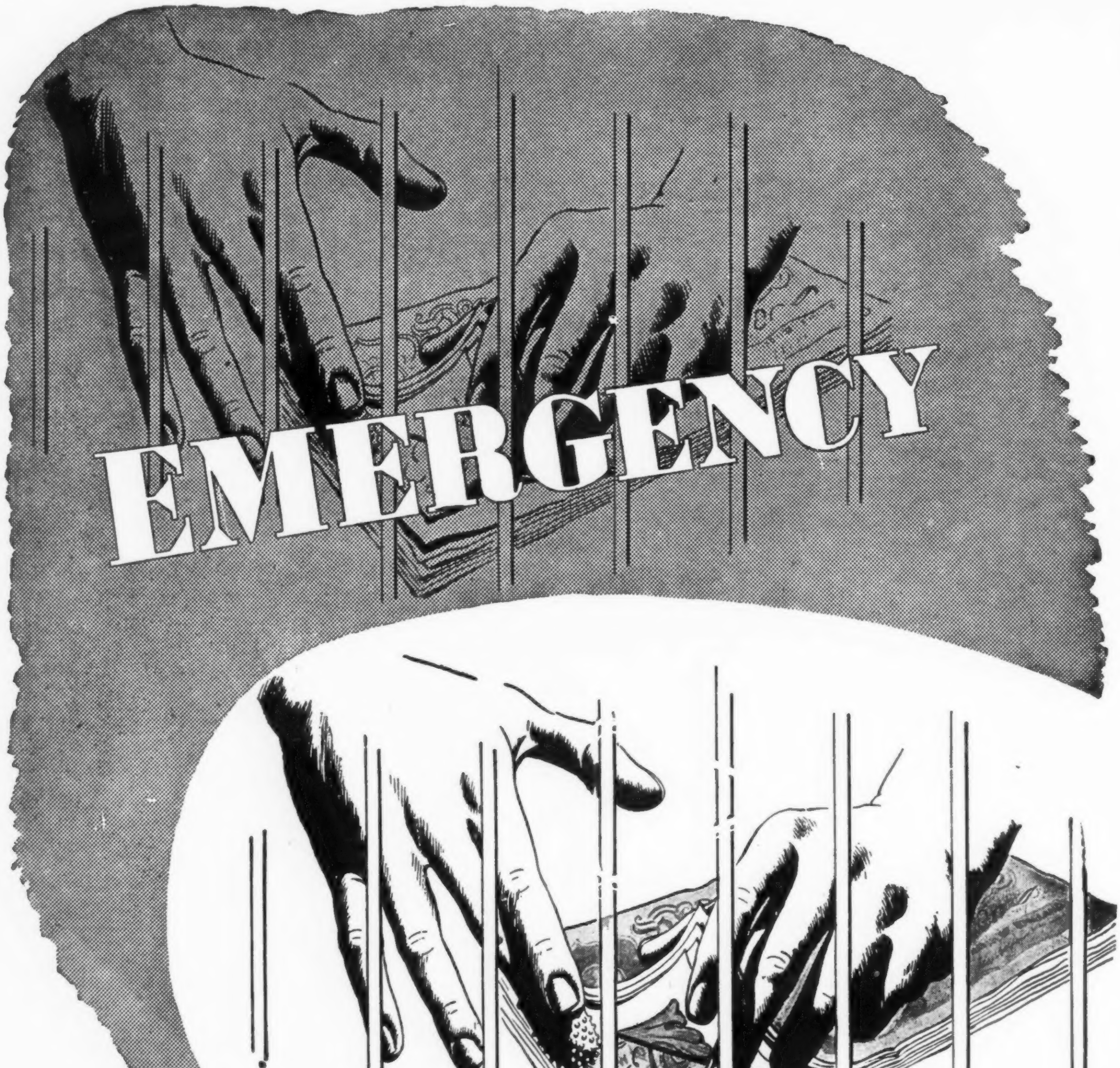
The contract comprises the Main Workshops Buildings, together with the Main Office Block, which is connected by a bridge to the Main Workshops Buildings. Overall dimensions, approximately 1,500 ft. x 560 ft., together with various Ancillary Buildings including Boiler House, Welfare Block, Materials Store and Service Block.

SOUTH DURHAM STEEL & IRON CO. LTD.

(Incorporating CARGO FLEET IRON CO. LTD.)

Central Constructional Department, Malleable Works, STOCKTON-ON-TEES, Co. Durham.

Telephone: Stockton-on-Tees 66117.



LIGHTING

In Banks, as in all buildings in which sudden darkness can impose the risk of theft, emergency lighting is a necessary precaution. In bank buildings of the future the installation of the standby system will be planned, as the main lighting is planned, by the architect. Chloride Batteries Ltd., makers of Keepalite, the automatic emergency lighting system, offer the advisory services of their engineers to architects in any part of Great Britain.

Keepalite

FOR BANKS

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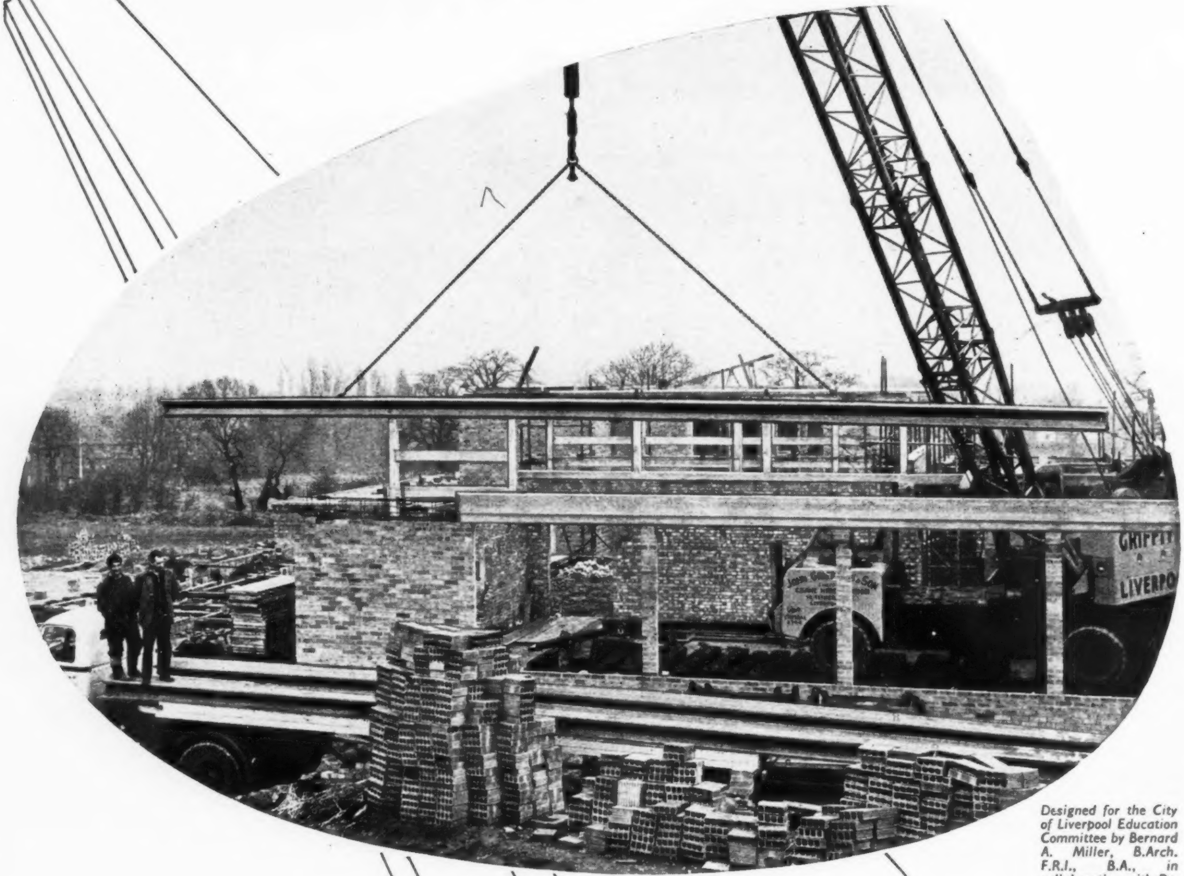

Designed for the City of Liverpool Education Committee by Bernard A. Miller, B.Arch. F.R.I., B.A., in collaboration with Dr. Ronald Bradbury, B.A. (Hon. Arch.), M.Sc., Ph.D., F.R.I.B.A., A.M.T.P.I., City Architect and Director of Housing.

PIERHEAD

PRESTRESSED CONCRETE

Pierhead I.10, 40ft. long Beam being lowered into position at the Out Lane County Primary School, Woolton, where all pre-tensioned floor and roof units were supplied and fixed by Pierhead Ltd.

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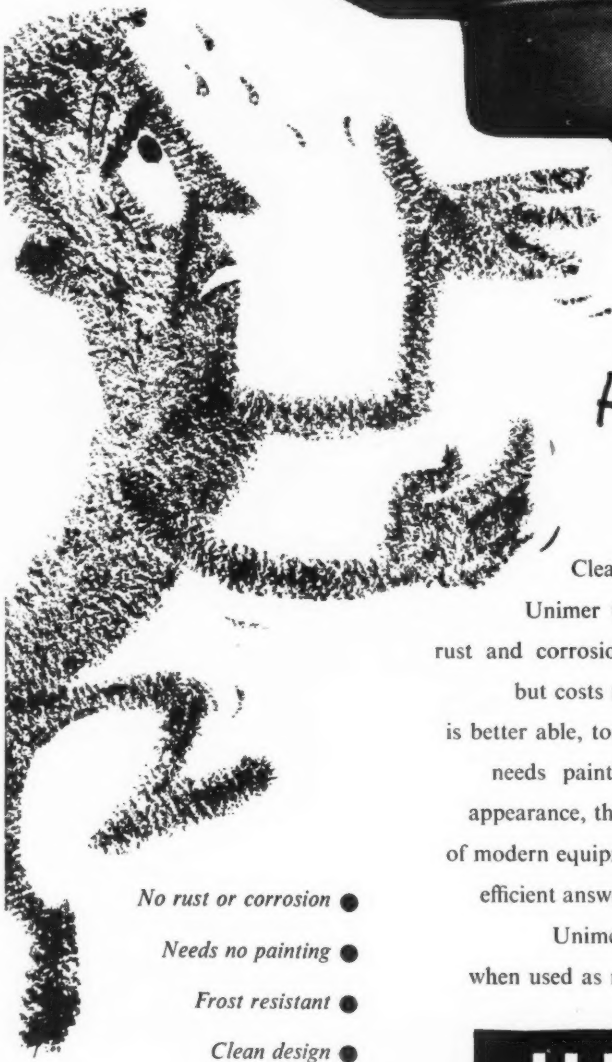

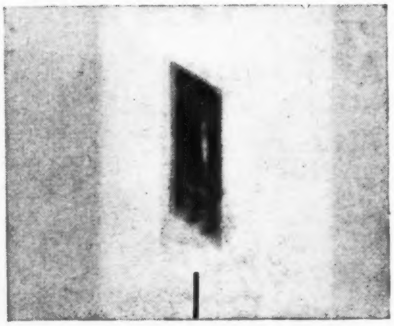

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Assistant Architect:
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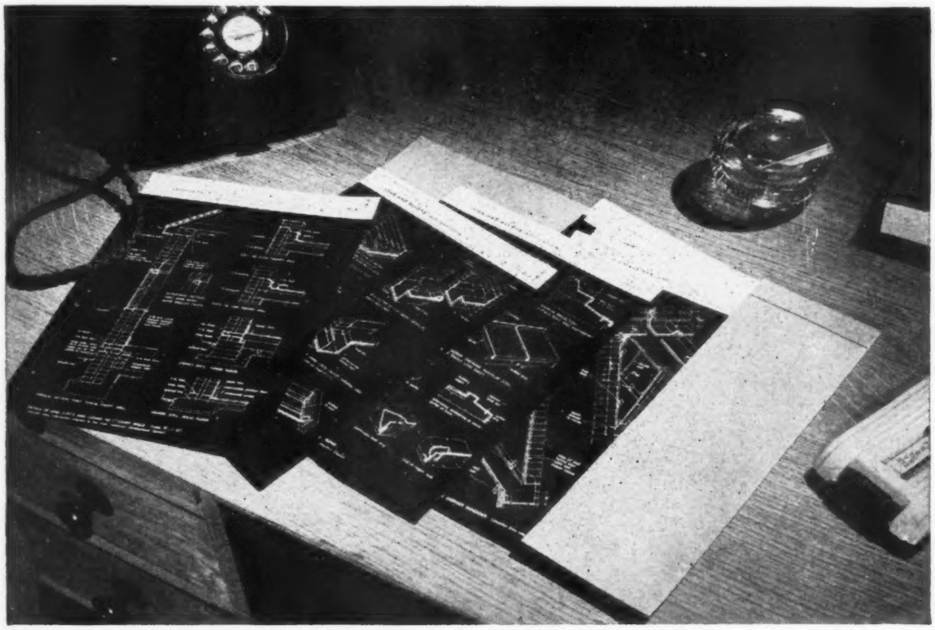

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INFORMATION SHEETS IN CURRENT USE

Ref.	*Title*
10.G1	Lead Flashing to Chimney on Slate or Tile Roofs
10.G2	Lead Flashing to Chimney on Pantile Roofs
10.G3	Lead Covering to Valley Gutters
26.A1	Details of Lead D.P.C.'s and Cloaks to 11" Cavity Walls
33.C1	Lead Plumbing to ranges of Lavatory Basins
33.C10	Laying and fixing Lead Service and Distribution Pipes
33.C2	Lead Plumbing to Ranges of W.C.'s
10.G4	Lead Flashings: Lead Slate and Ridge Saddles
10.GL0	Sheet Lead Weatherings to Projections and Canopies
33.C3	Lead Plumbing: Soil and Waste Pipes for Small Houses
10.G5	Lead Soakers to Mitred Tiled or Slated Hips and Valleys
33.C4	Joints for Lead Pipes: Characteristics
33.C5	Joints for Lead Soil and Waste Pipes: Characteristics
33.C6	Leadburned Joints for Lead Soil & Waste Pipes: Characteristics
10.G11	Sheet Lead Coverings for Flat Roofs
33.C7	Fixing Lead Soil, Waste, Ventilating and Rainwater Pipes
10.G20	Lead Flashings: Steel Roof Construction: Glazed Panel & Northlight
10.G21	Sheet Leadwork for Dormer Windows
10.G13	Lead Flashings to Asphalt & Built-up Bituminous Sheet Roof Coverings
33.C8	Installation of Lead Soil, Waste and Ventilating Pipes
33.C9	Lead Plumbing to Urinals
33.C11	Lead Plumbing for Laboratories
10.G12	Sheet Lead Coverings for Pitched Roofs
10.G22	Lead Flashing to Timber Framed Skylights
33.C12	Drawn Lead Traps: Standard Sizes & Applications to Domestic Appliances
10.G6	Lead Flashings to Mansard Roofs & Coverings to Hip & Ridge Rolls
10.G14	Lead-Lined Box and Tapered Gutters
10.G15	Lead Damp-Proof Courses to Chimney Stacks
10.F1	Lead Pipe and Lead Sheet for Building Work.

B137

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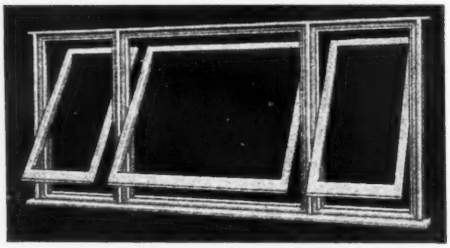

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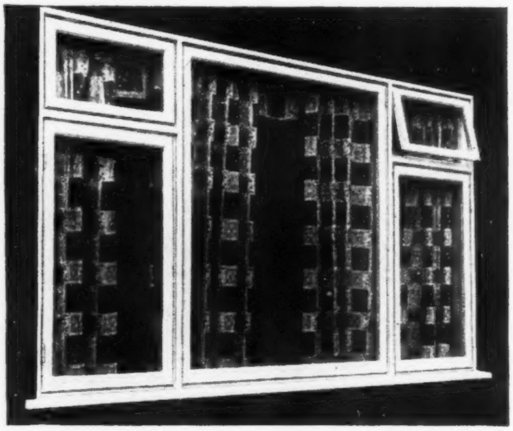
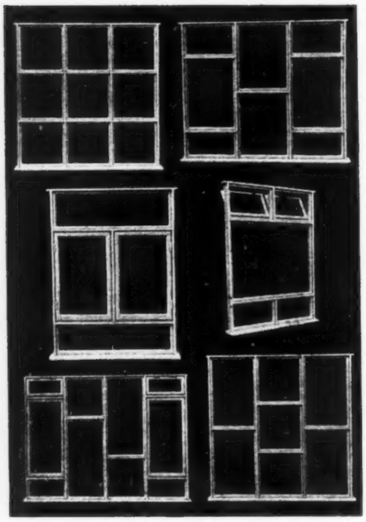


WINDOWS IN CONTEMPORARY STYLE



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This well planned residence, erected in Maralin Avenue, Bangor, Northern Ireland, illustrates how carefully selected clay tiles can add to the attractions of a building. In this instance, Dignus 11″ × 7″ dark antique tiles were chosen to blend with the rural background, but whatever the area, there is a Dignus tile to suit the purpose. Their economical size and pleasing appearance, make them a natural choice. May we send you further details ?

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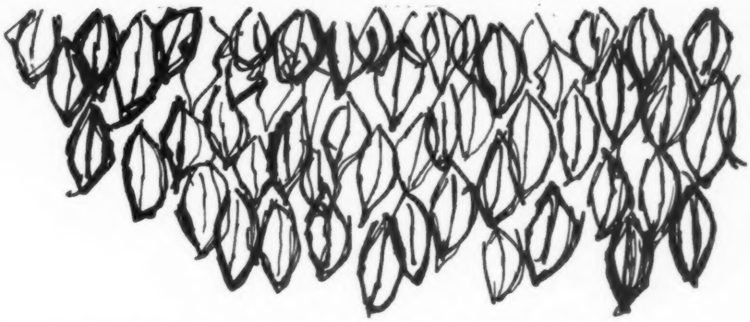

Fairy tales for Architects — number one

Once upon a time there was an ugly toad who lived in a duck pond in a sleepy village. Like so many ugly toads, it had once been a handsome Architect until changed into this foul shape by an evil witch. It all happened not so long ago.

One day as he was working in his office the Architect was visited by an important looking man who commissioned him to design and build a large block of offices. He told the Architect what he wanted and left him a detailed typewritten brief. He said: " I shall be gone for exactly two years but when I come back I shall expect the building to be finished and ready for occupation; should you fail in this task I shall immediately turn you into an ugly toad." And with these words he vanished into thin air.

The Architect set to work with a will, but after twenty months the building was still far from complete. The main work outstanding was the partitioning. He looked up his client's brief on the matter and read: " *I want the best partitions available; they must be easily demountable; the main offices must be finished in the choicest wood veneers; all the corridors must have demountable glazed partitions; all service pipes must be concealed and the partitions must be strong and have a good sound reduction factor. I want them finished flush without cover fillets or posts, and they must, of course, be competitive in price.*"

The Architect put down his brief and buzzed his secretary.

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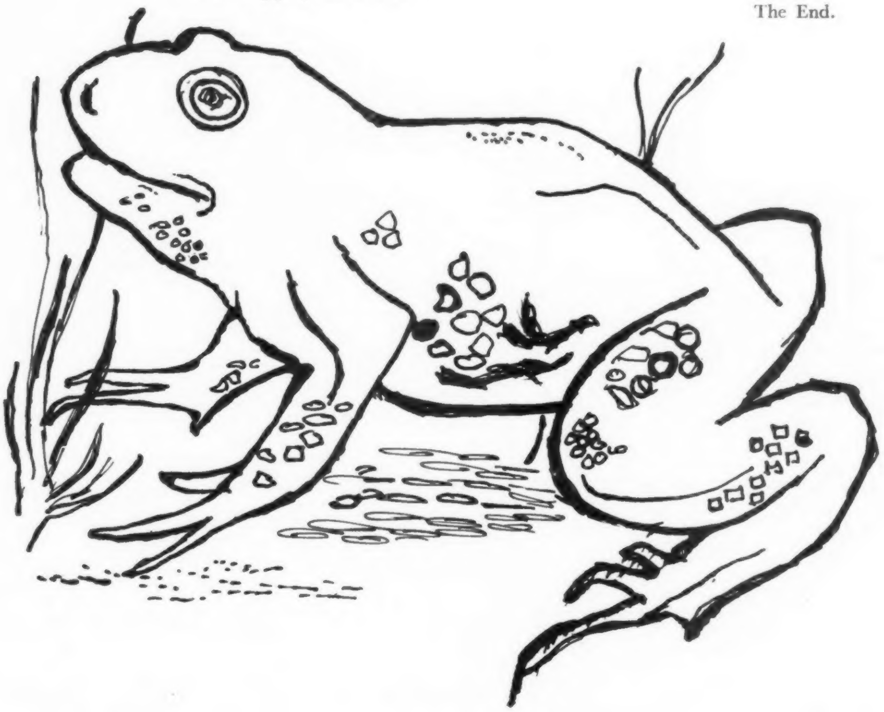
As a consequence of his telephone call the building was completed in time. When the important looking man returned on the appointed day he was very pleased, especially with the Werno Partition. He said, " You should know I am really a witch and because you have performed your task so well I shall grant you one wish." The Architect thought for a while and said, " I am tired of this nerve-racking city life, I would like a life of ease, free from responsibility and away from the madding crowd in some quiet place where I can spend my days by mossy banks, cool water and weeping willow trees. That is all I ask." So the witch turned him into an ugly toad in a sleepy village duck pond and he lived happily ever after.

The End.



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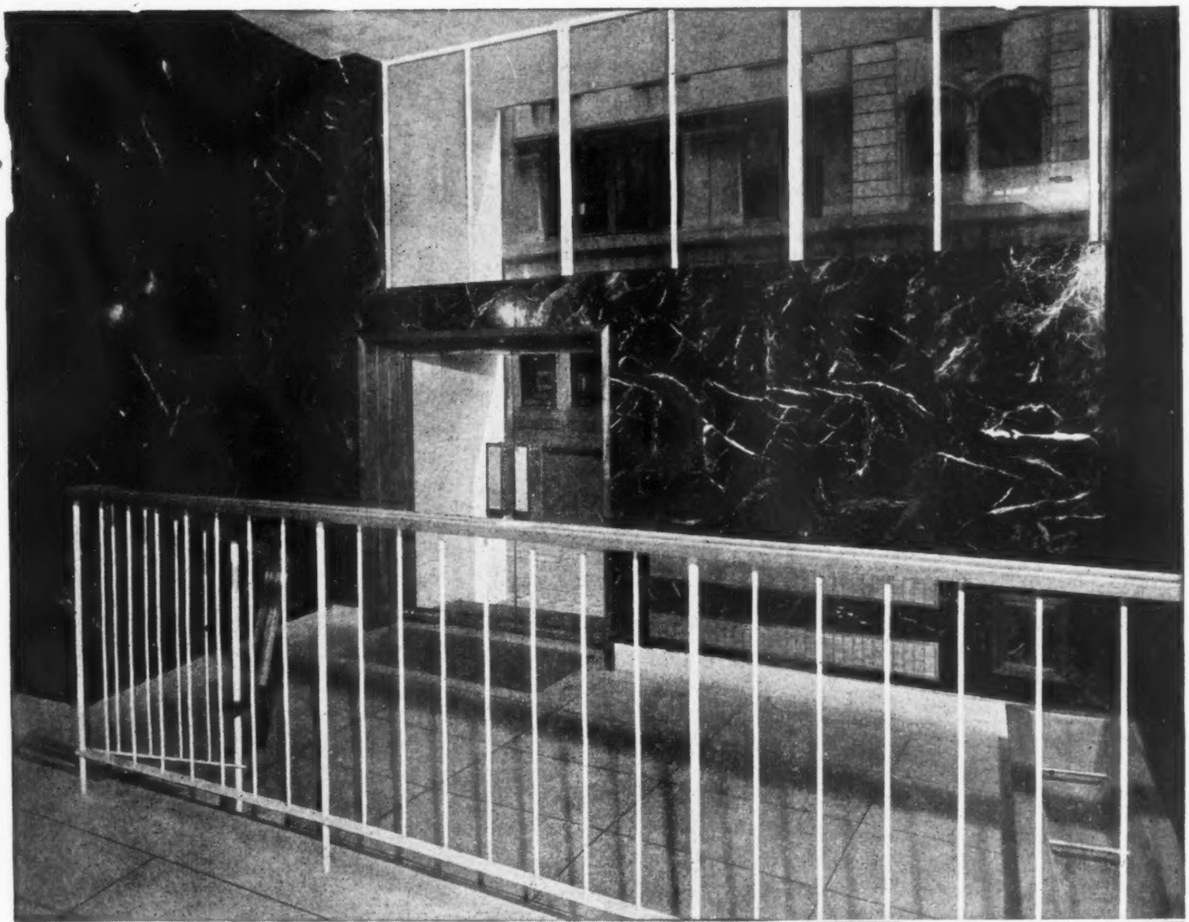
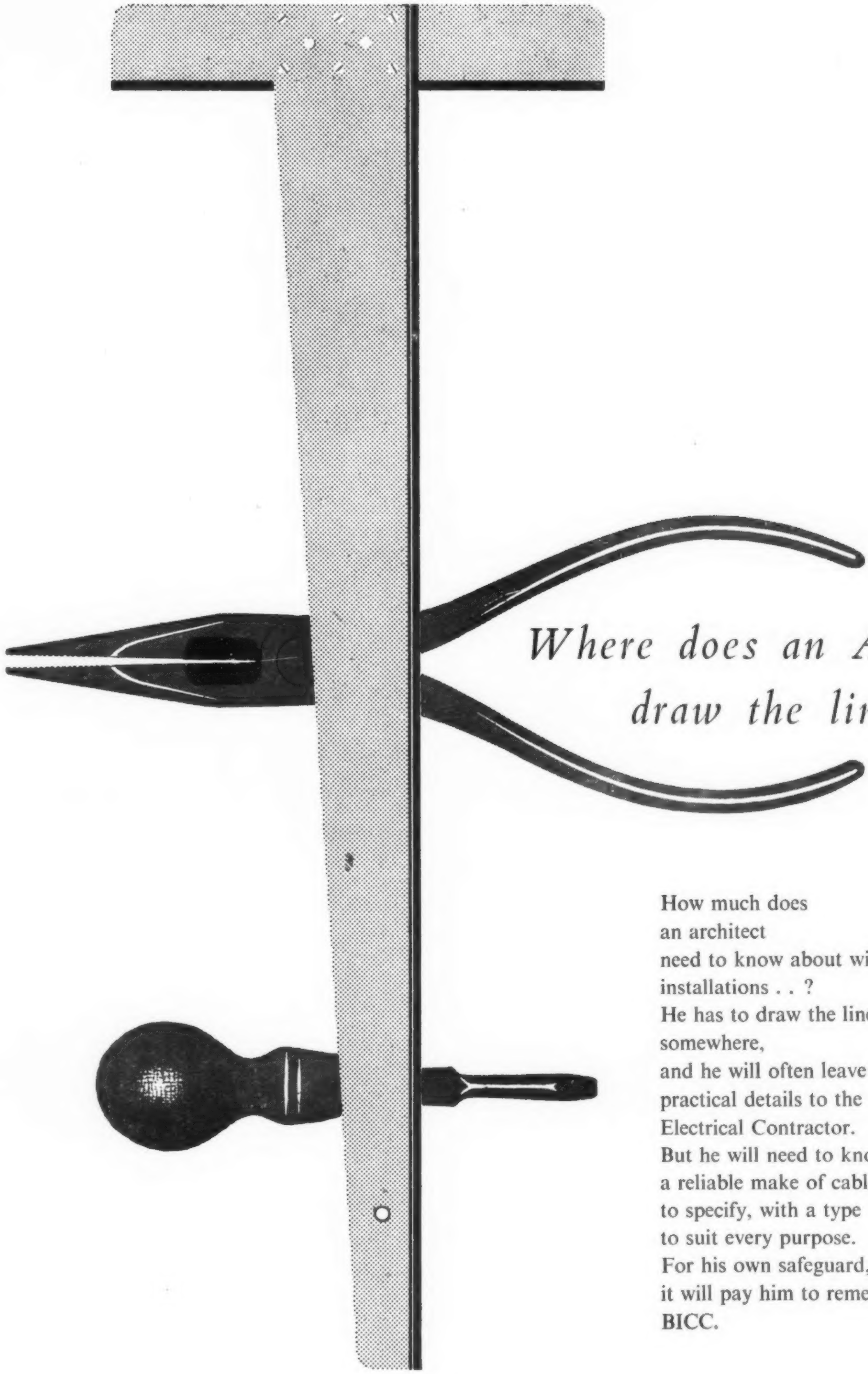


Entrance Hall and front view of 36/37 Queen Street, E.C.4.
Architect: Edward H. Eames, A.R.I.B.A.

The attractive green marble and mahogany entrance hall to 36/37 Queen Street has been designed for removal when plans for widening the street are put into effect. The set back will be achieved with minimum disturbance to the rest of the building. Partly repaired and partly rebuilt after war damage, this is another of the fine modern buildings constructed by Ford & Walton.



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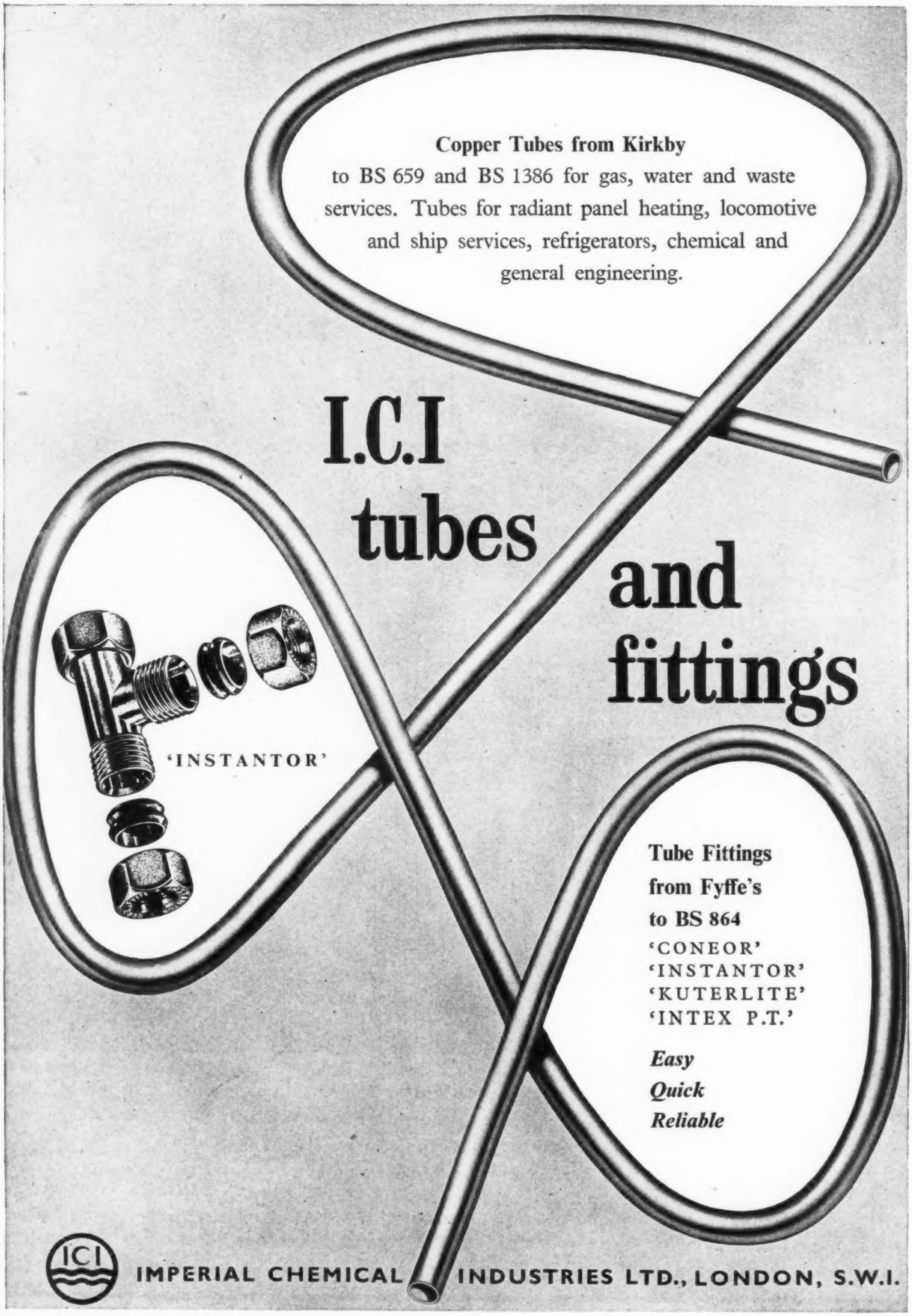
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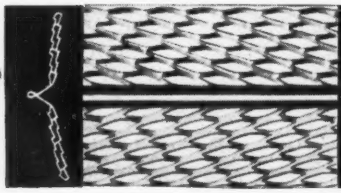

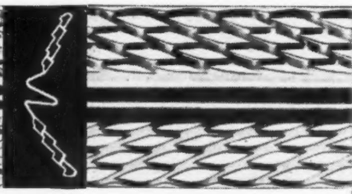

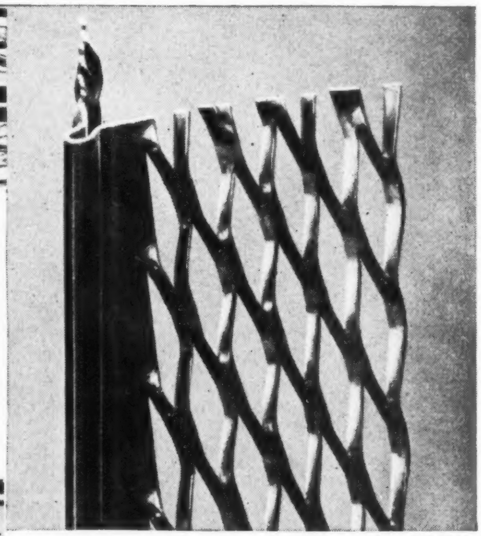

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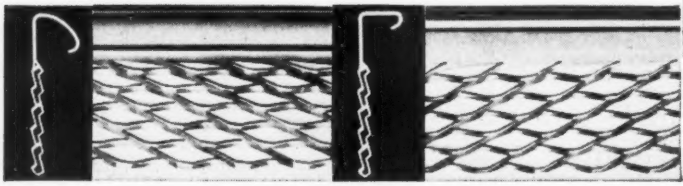

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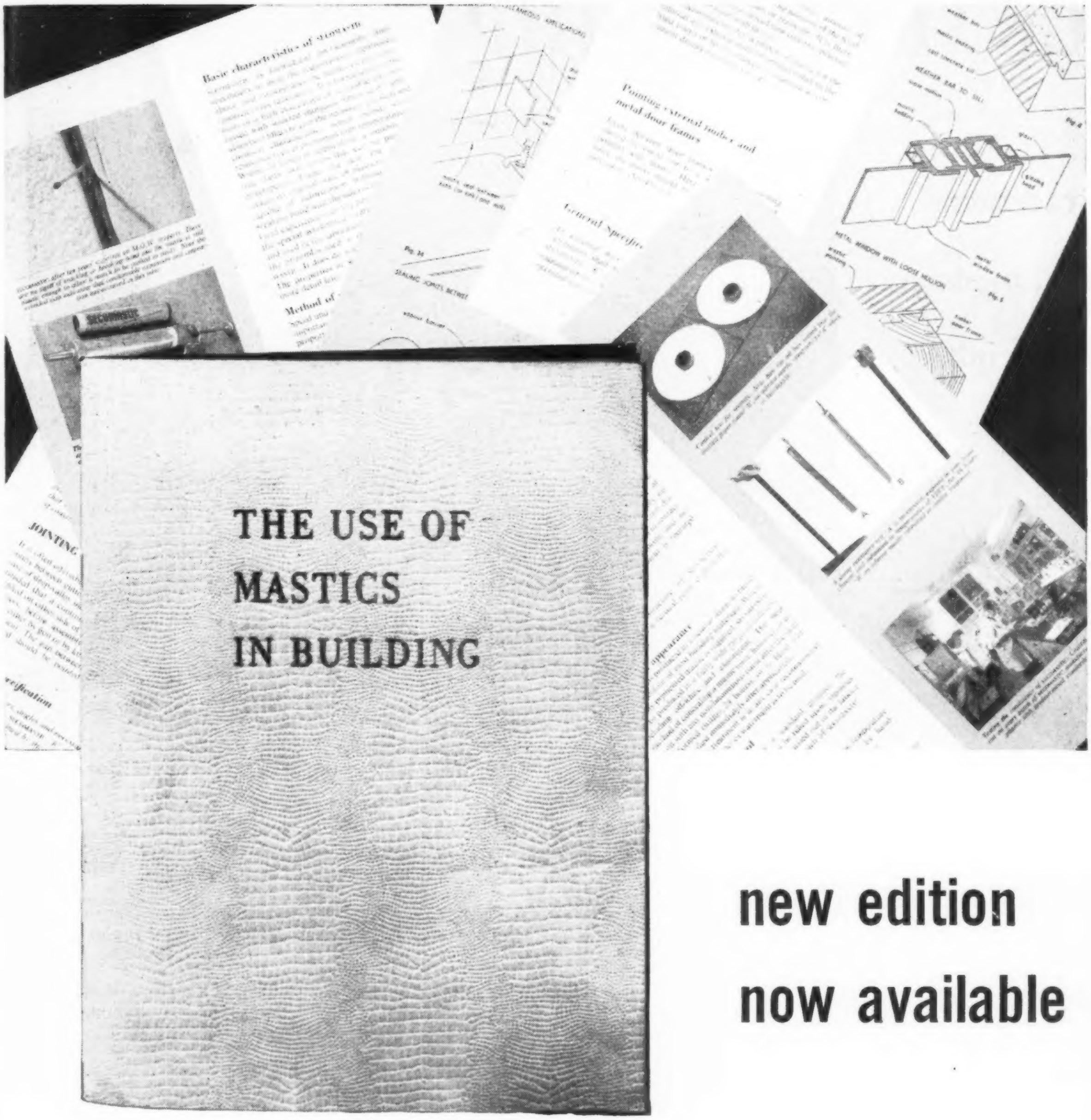

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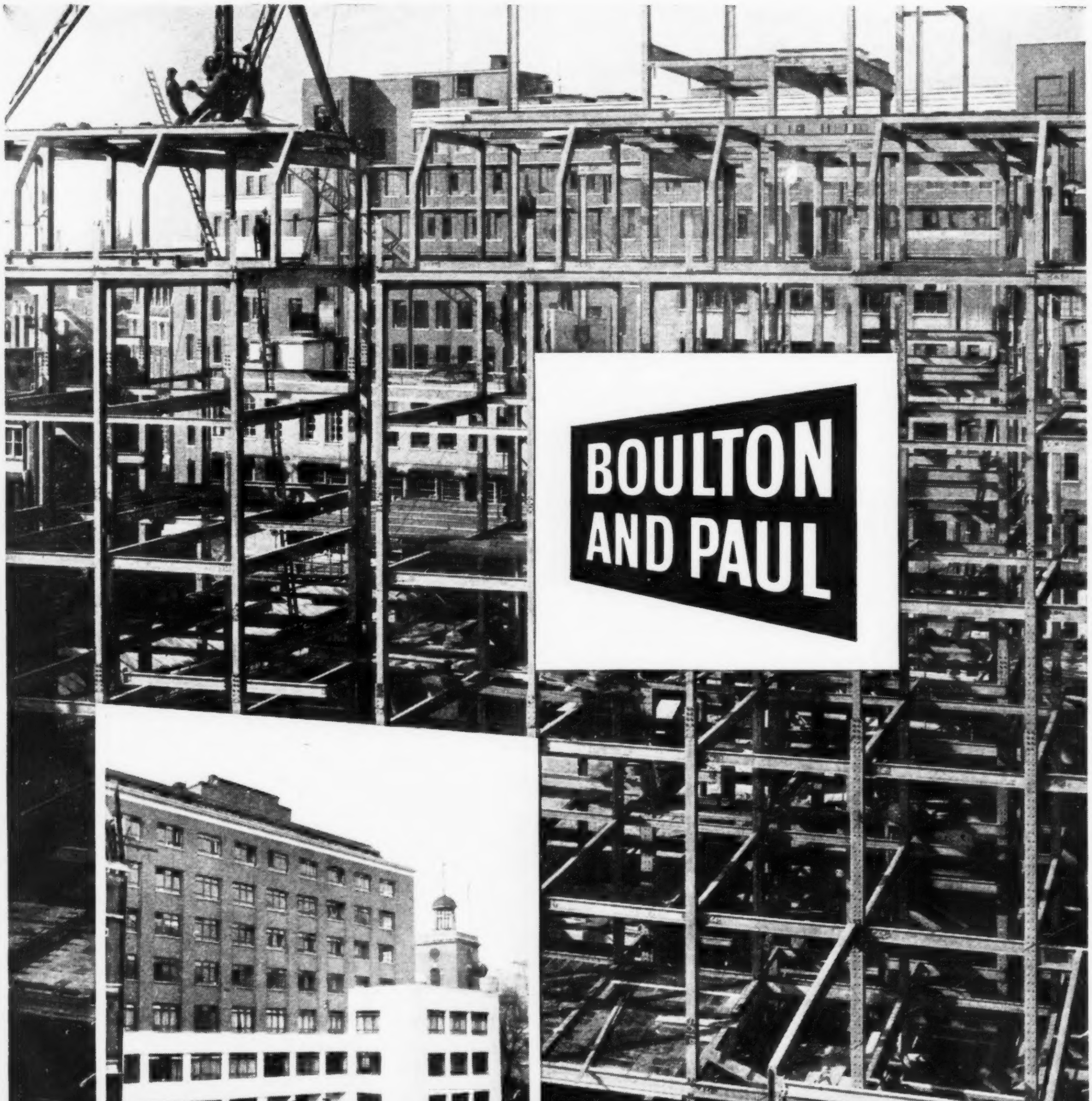

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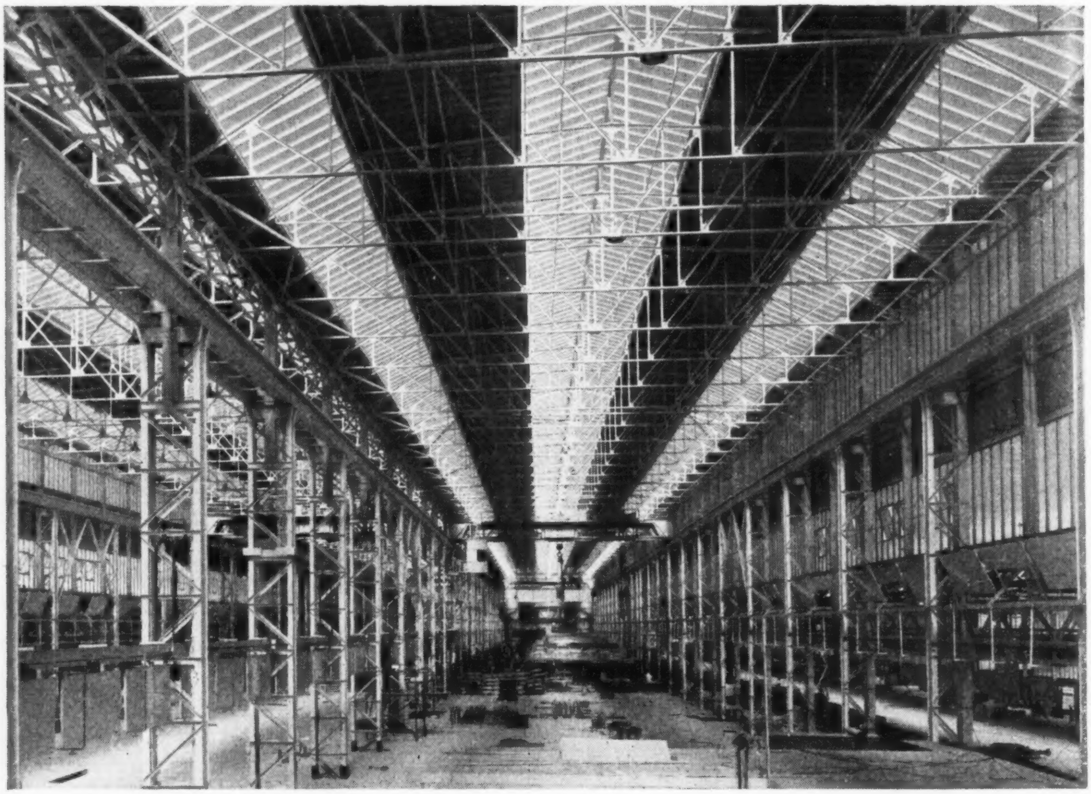

This fine new London Transport Executive Road Services Depot at Aldenham is the result of close and fruitful co-operation between the architects, the Patent Glazing engineers and various allied trades.

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Architect to L.T.E.: Thomas Bilbow, F.R.I.B.A. *Architect in charge: K. J. H. Seymour, F.R.I.B.A.*

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THE National Employers Federation of the Mastic Asphalt Industry and The Felt Roofing Contractors Advisory Board have recognised for some time that it is no longer normal practice in the Building Industry for specialist trades to issue Guarantees, particularly as modern contract conditions in the R.I.B.A. and other Forms of Contract in common use lay down specific requirements as to periods and conditions relating to the Defects Liability of the specialist contractor.

Long-term guarantees no doubt served their useful purpose in the Asphalt and Built-up Roofing industries in past days when these materials were untried and unproved, but such a basis for their well-established industries is now considered to be outdated and unnecessary.

The National Employers Federation of the Mastic Asphalt Industry and The Felt Roofing Contractors Advisory Board have therefore decided to reduce the length of guarantee and also to issue a Form of Guarantee common to both Bodies, and announce that as from the 1st July, 1956, all their Members will, on request, issue this Guarantee covering a period of twelve months from the Practical Completion Date of the Main Contract for Mastic Asphalt or Built-up Felt Roofing, Dampcoursing and Tanking and Asphalt Flooring against approved specifications. This one-year period will operate irrespective of the length of Maintenance or Defects Liability Period appropriate to the Main Contract.

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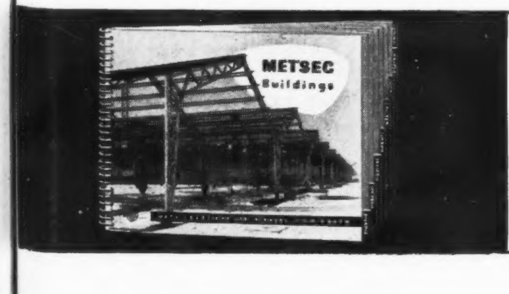

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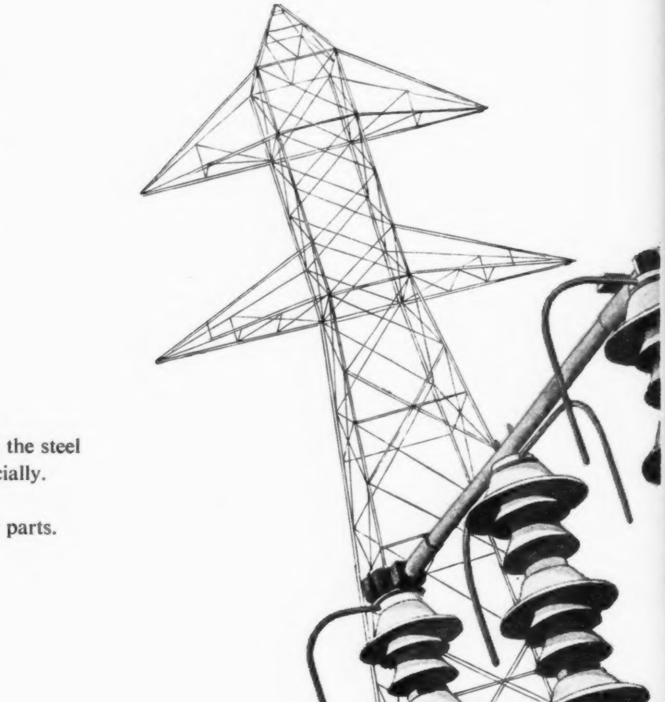

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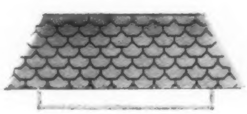

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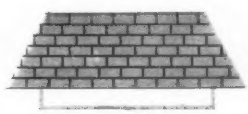

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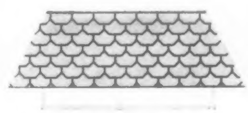

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No. 3200 Vol. 123 June 28, 1956

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DOMESTIC HEATING

CONTENTS page

To follow in next week's issue:

2. APPLIANCES AND SYSTEMS (CONTINUED)
Oil-fired Appliances for Domestic Heating. *G. J. Gollin*
Warm Air Systems. *Dr. W. Davidson.*
3. APPLICATIONS
Architectural Problems of Heating Multi-storey Flats. *A. W. Cleeve Barr.*
Future Trends in Housing. *J. H. Forshaw.*

"Is it up to Egerton standards?" is a question which is often heard in the good architect's office and which ought to be heard even more often. The question usually means "have the walls a U value of 0·20," but Egerton Standards cover room temperatures, ventilation rates, hot water supply and much else, and, if you want to know exactly what, you have only to turn to Post-War Building Study No. 19, Heating and Ventilation of Dwellings.*

If historians of English architecture a hundred years hence notice that, round about the mid-century, English dwellings became better insulated, more compact and generally more rational, this will be due in a very special sense to Professor Sir Alfred Egerton (left), the Chairman of the Committee which bears his name. Educated at Eton and University College, London, Sir Alfred holds, among many other distinguished posts, that of Emeritus Professor of Chemical Technology at the University of London and Editor of the quarterly Fuel.

Sir Alfred opened the Conference which is the subject of this issue by reviewing domestic heating since the publication of the Egerton Report in 1945. *Subsequent research by BRS and FRS has shown that the standards proposed were just about right; but when we come to see what we have done about implementing them the position is not encouraging. Particularly is this true of insulation. If our standards of insulation have in fact risen this is due (as Sir Alfred ruefully pointed out) not to intent but to accident: to the brick shortage which forced us to use an inner skin of concrete blocks and to the timber shortage which forced us to substitute solid for suspended ground floors.*

May we be more heedful of Sir Alfred's advice during the next ten years than we were during the last.

* Published by HMSO, 1945. Reprinted 1953. 5s. 6d.

The Editors

THIS ISSUE

ON May 1 and 2, 1956, the Institute of Fuel held a Conference at Church House, Westminster, on "Domestic Heating," the object of which was to discuss the three inter-related subjects of the production of fuels for domestic use, the heating of dwellings and smoke control. Prior to this Conference all the 45 papers prepared for it were published in a thick, paper-backed quarto entitled "Special Study of Domestic Heating in the United Kingdom."* At the Conference these papers were discussed (not very fruitfully, as it turned out) and some time in the autumn there is to be a further publication of the full proceedings. In the meanwhile it is evident that the subject is of first line interest to the architect. Embedded in this mass of print is material—some of it original—which can help him come to an informed opinion about heating. We have, therefore, with the permission of the Institute, prepared a summary of sixteen of the papers,† prefacing them with an introductory review which contains references to some of the remainder.

Determining what to summarize has been difficult: space is short and readers' time and patience are probably shorter. In the event we have summarized only those papers (or parts of papers) where the subject matter is of direct interest to the designer and where it is presented in sufficient detail to be a useful basic reference. Generalizations, however interesting, have been regretfully cut out. Our summaries have, in fact, been prepared for reference, not for light reading; and for this reason the real meat has been given straight, with only slight compression. But for those who really haven't time *just now* to wrap a towel round

* A few copies of which are still obtainable from the Institute of Fuel, 18, Devonshire Street, W.1 price £1, 1s. 0d.
† Of some we have summarized only a part.

their heads, but would like to know which way the wind (or smoke) is blowing, we print a summary of our summary in larger type at the head of each paper. Unfortunately shortage of space has prevented us from getting more than 12 out of the 16 papers of our digest into this number of the JOURNAL: the remaining 4 will follow next week. Also we have divided the subject matter differently from the organisers of the Conference. *Fuel production* is only referred to briefly in the introduction and *smoke control* not at all. After the introduction we begin with summaries of a short series of four papers (to be exact 3½) to which we give the general title of *The Background of Research*. This includes a rehearsal of our knowledge about comfort conditions and two excellent BRS studies on the field tests at Abbots Langley and on the cost of different heating systems and standards of insulation.

There then follows the main section, entitled *Appliances and Systems*—or as much of it as we can find room for in this issue. The section begins with *appliances*, with three papers on solid fuel, one on gas and one on electricity; and then passes to *systems* with two papers on central heating. Two more papers from this section are to follow in the next issue: one on oil-firing and the other on whole house heating by warm air. The third section, entitled *The Design of Dwellings*, has also been held over to next week's issue. It is very short, comprising only 2 papers, for it is here that our exclusion clause has had to operate most ruthlessly, and both of them relate to local authority work.

To make up for this we are proposing to print *the week after next* a little study, which we ourselves have been carrying out, on the running costs of a number of small houses which have been illustrated in the JOURNAL during the last few years and which have been heated by unconventional methods.

DOMESTIC HEATING

The first instinct of the architect on hearing that the technicians and publicists of the different fuels were gathering together to discuss domestic heating is to ask "who won?" and thence "for which fuel ought we to design?" The answer, perhaps unfortunately, is that nobody won: and the most we can say about fuel use during the next twenty or thirty years is that certain specific uses are likely to pass from one fuel to another.

From the national point of view fuels fall into two classes: those which derive from coal—solid fuel, gas and electricity*—and oil; but since, henceforth, both must be imported the distinction is not so significant as it used to be and the criterion for the use of either is how economically they can give us the heat we want. From the *social* point of view electricity and oil are the most favoured, simply on account of their convenience: but their extended use for the domestic load is hampered in the case of oil by the lack of the right sort of equipment and general know-how and in the case of electricity by the unfortunate fact that even though electrical appliances are 100 per cent. efficient the loss of energy in producing electricity from coal at the power station is such that this method of using coal is even more wasteful than burning it in the open fire. Sir Alfred Egerton was very downright about this and said that from the nation's point of view it was wrong that so much of our electrical output should be used on the production of heat, which could be produced so much more economically by other means, instead of by the production of power, which could not. It was doubtless for this reason that the extended use of electricity for *continuous* (as distinct from intermittent) space heating was much frowned on by responsible contributors at the Conference: Dr. Foxwell even going so far as to describe Mr. Moule's off-peak thermal storage heating as a desperate attempt by the Electrical Supply industry to fill up the troughs in their daily load by providing heat in the wrong place at the wrong time. Be this as it may, neither architects nor their clients are likely to give up either the actual convenience or the vision of the future which electricity gives: and we have the impression that we need only a few more turns of the technological screw (perhaps by the use of waste heat from power stations in the manner of Pimlico) for the balance of economy to be changed. For the time being, we must accept the fact that if a costly fuel is chosen, its use must be nicely calculated and no expense must be spared on insulation. Curiously enough, the only attempt to compare the cost of fuels was made by O. W. Humphreys in a paper entitled "Economic aspects of electricity for the domestic heating load." This attempt took shape in the graph we give in Fig. 1. The question is complicated, of course, by the fact that fuel prices vary, not only in time but throughout the country. The gas industry, for instance, is in the habit of altering the price of coke (for which there is an unlimited demand) in order to keep the price of gas competitive in the region. There are

* In fact a few power stations are firing oil, but this does not affect the argument.

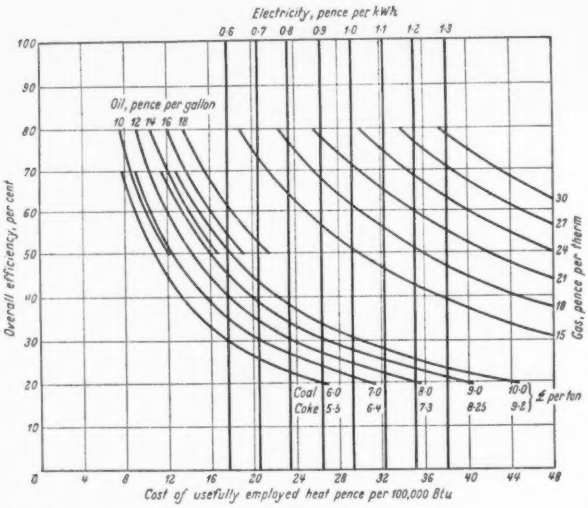


Fig. 1. Comparative cost of fuels.

thus two variables: the unit price of fuel and the percentage efficiency at which the fuel is likely to be burnt in an appliance. Both of these are taken into account in the graph, though in fairness we must point out that some of the facts were contested during the Conference.

Continuous and intermittent heating

For the architect observer one of the salient features of this review of our heating knowledge was the distinction to be made between continuous and intermittent heating. The Egerton Report, it must be remembered, called for continuous background heating and topping up in British houses: temperatures, it is true, were to vary from room to room and at different times of day, but the fundamental assumption was that we were to provide "steady state temperatures" in place of the "hot round the fire, cold everywhere else" which was the hallmark of British "comfort." BRS and FRS therefore, when they set about providing the fundamental research needed to implement the Report, worked on this assumption. For the Abbots Langley tests, for instance, BRS adopted the concept of "house mean temperature" to discover how much of the various fuels was needed to provide certain average temperature differences throughout the house throughout the heating season. This approach was challenged by protagonists of the two refined fuels (gas and electricity) which are particularly good at providing intermittent heating. These pointed out that the variability of our climate and the increasing tendency for the wife to go out to work and to leave the house empty during the day makes a mode of heating which will provide a quick warm up more to the point than one which will maintain steady temperatures (and hence occasion steady losses). This sort of argument can be carried too far: it is one thing, for instance, to provide a sudden flood of radiant heat in a bedroom for 10 minutes while you are getting into bed—which gas can do supremely well—and quite another to maintain full comfort conditions in a living room during seven hours on a winter's night, a feat which a refined fuel can do very well—but at a price. Again, one of the most interesting pieces of information to come out of the Abbots Langley tests was the influence of the thermal capacity of the building. Once the structure is heated it will provide a more important degree of background heat in nominally "unheated" rooms than we had imagined. This means in practice that the difference in cost between "whole house heating" and intermittent heating is not great and that better insulation, compact layout and a measure of open planning can bring he former within the local authority housing range.

This choice between the "quick warm-up," the option of being warmer or colder according to where you choose to sit on the one side and the maintenance of steady, even temperatures throughout the room on the other, can be observed through the whole range of appliances. In solid fuel, the old inset fire gives a quick warm up, the convector fire gives an even heat. The fuel technologist's dream is, of course, the continental closed stove: but a word of warning here. The heat it gives is almost wholly convective, therefore, in order to provide Dr. Bedford's "comfort conditions" (see page 735 and again page 737), *i.e.*, to make the people in the room feel cosy, you must work to an air temperature of 68-70° F., and where you have air temperatures of this order (as English people notice very quickly when they are abroad) you begin to feel stuffy and lethargic. Further, the higher the air temperature indoors, the greater the heat loss.

In gas appliances you have a choice between the older radiant fire which is unsurpassed for a quick warm up (in this respect the ordinary 16,000/18,000 Btu's radiant fire does as well as a 4-kWh electric fire—if you can get one that size) and the newer radiant/convector fire which uses some of its radiant heat (and heat which would otherwise go up the chimney) to produce a steady, even temperature. With electric appliances you have fundamentally the same choice: between the high temperature heaters with their coils or bars, the heat from which you can *feel* as soon as they are turned on and the low temperature heaters which give a steady, unobtrusive and relatively economic performance.

New equipment

For the architect interested in new ways of heating the Conference was disappointing. The spokesmen for the various fuels and appliances (with the exception of Mr. Moule and his electrical floor heating) tended to be cautious, if not deprecating, about new developments. The heat pump was mentioned several times, but Mr. Ackery of BEDA, the representative of thef uel most concerned in the development of the heat pump, made only a brief and damping reference to it (see page 756). District heating was represented by a report on the Pimlico scheme, which is not reproduced here as its interest for architects is limited to the confessedly important facts, first that the engineers were able to calculate the economics of the installation in advance (in happy contrast to another case we can think of) and second that the cost to the tenants has been about 10d. per therm. An interesting suggestion was also put up by H. H. Bruce of the Invisible Panel Warming Association for district heating (perhaps more properly described as block heating) for groups of 50 houses (see page 760).

Insulation

We get out of our fuel only a little more than half the heating value that is got by most of the nations of Northern Europe. Sir Alfred Egerton gave his opinion that if we are to right this tremendous national scandal we shall do it, not so much by improving the efficiency of appliances (which accounts for only a small part of the delinquency) as by improving our standards of insulation—by which is meant, of course, not only reducing the heat loss through enclosing walls, but reducing their area by skilful planning. H. F. Broughton and G. D. Nash of BRS show in their paper (page 741) that the cost of improving the insulation of their semi-detached house from the "postwar" U value of 0·38 to a proposed next-stage U value of 0·24 was only £35. Dr. Foxwell in his summing-up calculated that this would save each householder a ton of coal every year. The tragedy of insulation is that as things are at the moment, with 8¼ out of 12½ million dwellings rented by their occupants, the people who build and own most of our houses have no

incentive either to install efficient equipment or to insulate. The answer to the first may be to make heating equipment the property of the tenant: the answer to the second can only be to persuade the Treasury, householders and tenants to see the importance of this kind of "productive" capital expenditure. Architects eager to calculate heating requirements and heat loss down to the last therm will want to know "have we sufficient data to do it?" The answer is "Well, very nearly." One important missing link in the design chain is pointed out by J. A. Forshaw (page 756), namely that the ratings of domestic appliances are not all available. Other writers (*e.g.*, Dr. F. J. Eaton and S. Stephens on page 760) point out that there are three different methods of rating current for different classes of boiler and that none bear a realistic relationship to the manner in which the boiler is likely to be used. Architects will envy the simple system practised in Holland (page 746) where the designer has merely to divide the Btu rating by six to get the volume to be heated! In any case JOURNAL readers will want to join with Mr. Forshaw in urging the Institute of Fuel to do something about it, and in the meanwhile to compliment the Institute on having staged a first-rate Conference.

Comfort in the Home 1

by Thomas Bedford, D Sc, Ph D, of the Medical Research Council's Environmental Hygiene Research Unit, London School of Hygiene and Tropical Medicine.

1
The background of research

Dr. Bedford begins by discussing the amount of air needed for comfort and points out that by restricting the throat of the flue, or by dispensing with the flue altogether, we are liable to give insufficient ventilation to keep down body smells. He suggests it was a pity that the new model byelaws removed the obligation to fit an air-grating in flueless rooms. He then rehearses briefly the conditions of comfort in respect of "equivalent temperature," thermal gradients, the horizontal spread of heat, and draughts. Finally he questions whether it is really necessary to provide the background heating in bedrooms called for in the Egerton Report.

Before considering the conditions of heating which make for comfort it is necessary to consider ventilation. For the past 100 years the standard of ventilation has been the amount of air needed to keep down body smells. This was established (in 1936) at about 600 cu. ft./hr. for each occupant, a figure which was accepted by the Egerton Committee for living rooms and bedrooms, though for kitchens 1,000 cu. ft./hr. was called for. These are minima for the winter: in hot weather you want more air. This amount of ventilation is easily got with a solid fuel open grate with an unrestricted flue of 50 sq. in. cross section, whether the fire is lit or not; but where there is no flue or where the opening is restricted, ventilation becomes critical. Experiments in the BRS Experimental Room (1939) showed the following results:

	average air changes per hour
unrestricted flue and no heating	1·7
as above, but coal fire burning	4·5
as above, with gas fire burning in fireplace	3·1
anthracite stove burning and restricted flue	0·7

With the last example a living room of 2,000 cu. ft. would only show a supply of fresh air of 1,400 cu. ft. hr., that is, enough for two people, and it would be necessary to open a door or window to achieve the Egerton standard if there were more. Further experiments at Abbots Langley on houses on an exposed site showed (at an average wind speed of 8·5 mph) that with doors and windows closed all rooms but one maintained an *average* supply of fresh air of up to or above 600 cu. ft./hr., and that the supply in the one room was not much below. It showed also that in calmer weather the ventilation in some rooms fell far below this figure.

Investigations in flats showed even more unsatisfactory results. Tests carried out on double bedrooms of 1,070 cu. ft. and 940 cu. ft. respectively showed average ventilation rates of only five-eighths of the Egerton Standard. Other investigations showed that an air grating of only 10½ sq. in. area increased the ventilation rate by 50 per cent., and it seems a pity that the former obligation to fix such an air grating in a flueless room was removed in the new Model Byelaws.

The Warming of Living Rooms

Four thermal factors govern our feelings of warmth: radiation from the surroundings (whether heat sources or cold walls) and the temperature, humidity and speed of movement of the air. Of these, at temperatures met in this country, air humidity has little effect on our *sensation of warmth*, even though it may be otherwise unpleasant. There are thus three significant variables, radiation, air speed and air temperature, and in the Egerton Report an index is described, known as *equivalent temperature*, which takes these three into account.

In considering living room heating there are four factors to be considered: what equivalent temperatures to aim at, how to limit the thermal gradients (i.e. the air temperature differences at different heights), how to distribute the heat evenly in the horizontal planes, and how to limit draughts.

The Egerton Committee found 65° F. to be a reasonable equivalent temperature for the living room, adding that most people can find comfort within the range 62°—66° F.* With air and walls at the same temperature and with an air speed of about 20 ft./min. the latter equivalent temperatures would call for an air temperature range of 64°—68° F. Much depends, of course, on what people are doing in the room: it may well be that people relaxing at the end of the day want a slightly higher temperature. Munro and Chrenko, in their paper on the effect of radiation from the surrounds on subjective impressions of freshness, reported that most people preferred 67° F. equivalent temperature or rather more or an air temperature of 70° F.

The difference between air and equivalent temperatures, and hence how high an air temperature is needed to produce a given equivalent temperature, depends on the type of heating used, whether radiant or convective, and on the temperature of the surrounding wall surfaces. To take the second of these first, the temperature of a wall surface depends chiefly on the thermal transmittance of the wall. If the outside walls of the living room are insulated to the Egerton Standard (*i.e.*, 0·15 Btu/sq. ft./hr./°F.)† the temperature on the inner surface will be about 3° below the air temperature in the range in question; but if the wall has a thermal transmittance of 0·40 Btu/sq. ft./hr./° F., as is common in old houses, then the surface temperature may be as low as 9° F. below air tem-

* This is described in greater detail (using Dr. Bedford's own data) in O. W. Humphreys' paper on page 736.

† This was the standard for *Living rooms*: other external walls must not be above 0·2 Btu/sq. ft./hr./°F.

perature, and more fuel will be wanted to produce the required air temperature. Even if this is produced, people will not be as comfortable as they would be if the walls were warmer: the experiments of Munro and Chrenko showed that the environment was freshest when the walls were *warmer* than the air temperature, and were distinctly stuffy when the walls were cold.

The Egerton Committee recommended that thermal gradients between head and ground level should not be greater than 5° F. This needs careful planning when heating is mainly by convective sources: a large volume of air heated to a relatively low temperature is better than a small volume of air heated to a relatively high temperature. When the elements are within the room they should be placed as near to the floor as possible and extensive sources at low temperatures are better than narrow ones at high temperatures.

Two sets of experiments in particular show the truth of this. In 1942 Dufton and Marley reported the effects of warming an unventilated room with one cold wall by three different methods and gave the following results:

	temp. gradient at 5 ft. above floor
six column hot water radiator 32 in. × 18 in.	4·4°F
electric convectors	6·1°F
tubular heaters mounted near floor	1·8°F

The earlier work of Willard and Fahnestock (1930) comparing tall column-type and long, low, narrow wall-type steam-heated radiators showed that the former produced a gradient at head level of 11·3° F. and the latter one of only 1·9° F.

The Egerton Committee concluded in their report that ceiling heating should not be used in rooms less than 12 ft. high. We now know that the effect of stuffiness experienced in ceiling heat is caused not by the radiant temperature of the ceiling source

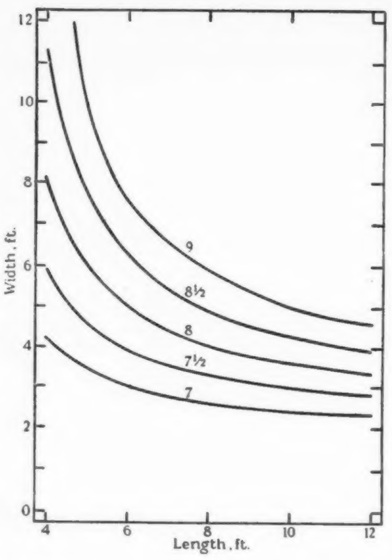


Fig. 1. Maximum desirable dimensions of a rectangular ceiling panel operating at a temperature of 100° F. for different heights of ceiling.

so much as the *difference* between this and the temperature of the floor, which must not be greater than 4° F. bulb temperature. For this reason the size and shape of the panel is critical. The graph in Fig. 1 shows the permissible dimensions for panels heated to 100° F. for different heights of ceiling. Much experimental work has been done recently on floor heating and it seems generally agreed that the temperature of a warmed floor should not exceed 75° F.

Turning to the question of uniformity of heat in the horizontal plane, Fishenden and Willgress, in *The Heating of Rooms* (HMSO, 1925), demonstrated very clearly the ineffectiveness of the open fire in this respect. They showed that with air temperatures of 60°, 55° and 50° they required mean horizontal components from the fire 30, 75 and 120 Btu/sq. ft./hr., respectively, and that in the experimental room in question (19 ft. by 19 ft.) these components were obtainable over only 60 per cent., 19 per cent. and 7 per cent., respectively. Another point which has come to light more recently is that some open fires direct their heat at an angle of 50°-60° from the horizontal: it is preferable that they should direct their heat to the lower parts of the body and not to the face.

Air speeds of less than 15 ft./min. cause stuffiness, while those of more than 40 ft./min. can be felt as a draught. Recent subjective experiments on this in a factory have shown that there is no consistent relation between air speed and complaints, but that complaints become decidedly more frequent with air speeds greater than 40 or 50 ft./min.

Warming of Other Rooms

The Egerton Committee advocated bedroom temperature of 50°-55° for dressing and undressing, also that the bedroom temperature should not fall below 45°-50° during the night, and that one bedroom should be capable of being heated to 65° F. They also advocated the background warming of bedrooms because:

(i) if there is no heat people will not ventilate their bedrooms properly;

(ii) an unheated room is liable to be damp.

The increase in the cost of heating since the publication of the Report suggests that this may be extravagant. It is doubtful if people are more likely to ventilate their bedrooms when they are heated, though it is certain that if they do so the heat loss will be considerable. Provided one room is capable of being heated up to 65° F. there is a strong case for relying entirely on gas or electric fires.*

* See also the evidence from the Abbots Langley tests (page 739) which shows that temperatures in nominally "unheated" bedrooms were on average only 1·6° F. lower than those with background heating.

The background of research (continued)

Comfort in the Home 2

by O. W. Humphreys, B Sc, F Inst P, M I E E

This summary relates only to part of a paper, the title of which was "The Economic Aspects of Electricity for the Domestic Heating Load." It is included here first because the author sets down in greater detail the research findings on comfort conditions outlined in Dr. Bedford's paper (see page 735); and second because, in applying this information to the problem of heating a typical living room, he illustrates the value of good insulation, not only in providing given temperatures at lesser cost, but in providing conditions of greater comfort (i.e. by making possible higher mean radiant temperatures from the inside enclosing surfaces). The author concludes by giving the estimated cost of maintaining four different air temperatures in a two-storey 1,850 sq. ft. house by means of electricity.

Thomas Bedford, as a result of his investigations of the relationship between environmental conditions and comfort, established an empirical formula based on the temperature of the air and the mean radiant temperature of the surrounding surfaces. Using these two factors as coordinates he was able to plot a series of straight line "curves" corresponding to conditions described by the subjects of his experiments as "comfortably warm," "comfortable" and "comfortably cool."

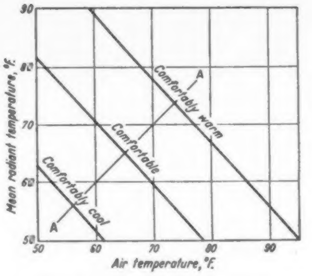


Fig. 1. Bedford's comfort curves. Combinations of air temperature and mean radiant temperature corresponding to various standards of comfort. (Partial pressure of water vapour taken as 10 mm. Mg. and air velocity as 16 ft./min.)

These curves, which are given in Fig. 1, illustrate a number of points which are essential to an understanding of domestic heating. The first is that if and when the air temperature and the mean radiant temperature are the same, comfort is obtained at 65° F. This condition is shown by the line AA. If, however, the mean radiant temperature is less than 65° F., it is necessary to raise the air temperature to a proportionate amount if the same comfort conditions are to be obtained. Thus, if the mean radiant temperature drops to 60° F., the air temperature must be raised to 69·5° F. If the mean radiant temperature drops to 55° F. the air temperature must rise to 74°, and so on. Another point to be noticed is that *above* the line AA the mean radiant temperatures are *higher* than the air temperatures, a condition which could only apply if the surfaces were themselves heated. Assuming that these surfaces are *not* heated, their mean radiant temperatures fall somewhere between the inside air temperature and the outside air temperature. If a wall is well insulated the surface temperature will be closer to the inside air temperature for any given inside/outside temperature difference than if the wall were badly insulated. The effect of this can be seen in the graph in Fig. 2.

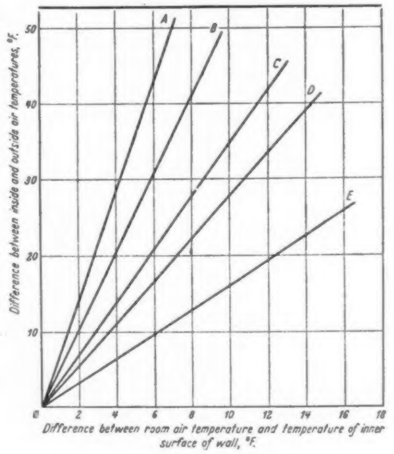


Fig. 2. A: recommended wall (BS. CP.3), U = 0.20. B. 11 in. cavity brick wall, U = 0.28. C: 9 in. brick wall, U = 0.41. D: double glass window, U = 0.51. E: single-glass window, U = 0.88. U is in Btu./sq. ft. ° F.h.

In order to show the operation of this it is proposed to take a typical living room 16 ft. by 12 ft. by 8 ft. 6 in. high with two inside and two outside walls, to assume that this room is to be maintained to Bedford's "comfortable" conditions and to calculate what would be the air temperatures needed and the heat losses which would ensue; and to repeat the calculations for different degrees of insulation in the walls. In order to do this it is necessary to assume a ventilation rate (2 air changes per hour) and to assume certain unchanging characteristics in the internal structure. The ground floor is wood, linoleum-covered, ventilated below; the first floor structure is wood, and the partitions are 4½-in. brick, plastered both sides. The results of these calculations are given in Table 1. The difference between case 1 and case 2 relates only to the question of whether the rest of the house is heated to the same temperature or not. The remaining figures show that for any given outside temperature you get about 0·5° F. difference in the room air temperature to be maintained for each successive improvement in insulation specified: this does not seem much, but, as we shall see, it makes a significant difference to heating costs.

The next piece of evidence to be studied is that provided by Margaret Fishenden and R. E. Willgress from their tests determining by how much air temperature can be reduced if a person in a room is subjected to direct radiation from a high temperature source. Their graph shown in Fig. 3 shows the amount of radiant heat (expressed as a horizontal component in Btu/sq. ft./hr.) required to make the person comfortable in rooms of differing air temperatures. Thus they found that whereas with the room air temperature of 65° F. the person is comfortable without any radiant heat, the person is comfortable if the room temperature drops to 60° F. if he also receives radiation having a mean horizontal component of 30 Btu/sq. ft./hr. They also found that an air temperature of 55° F. with the right amount of radiant heat (*i.e.* 75 Btu/sq. ft./hr.) was "more invigorating" than when the air was higher and the radiant heat proportionately less. They also found that room air temperatures below 52° F. gave rise to the "scorched on one side, chilly on the other" feeling.

The Quantity of Heat Wanted to Maintain Specified Conditions

The method specified in the Egerton Report for calculating how much heat is wanted to maintain a building is that of "degree

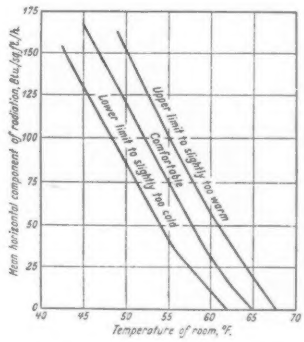


Fig. 3. Radiation required for comfort with different air temperatures.

TABLE 1.
TEMPERATURES OF AIR AND BOUNDING SURFACES REQUIRED FOR COMFORT, IN A TYPICAL ROOM, FOR VARIOUS STRUCTURES AND OUTSIDE TEMPERATURES

Case	Structure and heating conditions	Outside temp., ° F.	Room air temp. (° F.) required for comfort*	Corresp. mean radiant temp., ° F.	Lossess from room, Btu./h. (2 changes of air per hour)
1	Outside walls 9 in. brick ($U = 0·41$). Single glass window. Rest of house unheated	10	72·4	56·6	23,200
		20	71·1	58·0	19,000
		30	69·7	59·5	14,800
		40	68·3	61·0	10,500
		50	66·9	62·6	6,300
2	As Case 1, but rest of house heated to same temperature as room	10	70·0	59·5	15,800
		20	69·1	60·5	12,900
		30	68·2	61·5	10,100
		40	67·4	62·4	7,200
		50	66 5	63·4	4,300
3	Outside walls 11 in. cavity ($U = 0·28$). Single glass window. Rest of house heated same temperature as room	10	69·4	60·1	14,400
		20	68·6	61·0	11,700
		30	67·8	61·9	9,100
		40	67·0	62·8	6,500
		50	66·2	63·7	3,900
4	As Case 3, but with walls as recommended in B.S. Code of Practice, C.P. 3 ($U = 0·2$)	10	69·0	60·5	13,500
		20	68·3	61·3	11,000
		30	67·6	62·0	8,600
		40	66·9	62·8	6,100
		50	66·1	63·6	3,700
5	As Case 4, but with double glass windows	10	68·4	61·1	11,800
		20	67·8	61·8	9,700
		30	67·2	62·5	7,500
		40	66·6	63·2	5,400
		50	66·0	63·9	3,200

* The standard of comfort defined by Bedford as "comfortable."

days." You decide the air temperature you want to be maintained. You subtract 5° F. from it to allow for fortuitous heat gains. This is the "base temperature." A degree day is the difference in degrees Fahrenheit between this base temperature and the average outside temperature during a 24 hour period. The allowance of 5° F. for fortuitous heat gain is thought to be excessive, and it is proposed therefore in the tables which follow to show figures allowing both 5° F. and what is felt to be a more accurate figure of 3° F. This adjustment, as will be seen, makes a considerable difference in the results.

The average outside temperatures during past years are, of course, known. In Table 2, therefore, we give the number of degree days required to produce a range of maintained temperatures, using both the Egerton and our modified formula. It will be noticed that the number of degree days falls spectacularly with each 5° F. drop in the temperature to be maintained and that (to take an example using the modified degree day basis) to maintain a base temperature of 50° F. requires only between a fifth and a sixth of the degree days required to maintain 65° F.

What this means when applied to a typical house can be seen by reference to Table 3. The house is two-storeyed, with external dimensions of 35 ft. by 30 ft. and a floor area of approximately 1,850 sq. ft. Walls are 11 in. cavity brickwork, the roof is tiles on boarding and felt, the ground floor is wood blocks on solid concrete, the area of window allowed for is a third of that of the outside walls, and the ventilation rate is two air changes per hour. The main point to be noticed from the table is the striking difference in cost between maintaining a high and a low air temperature but an important subsidiary point is the very big difference in the cost of maintaining the 50° F. level when calculated on the ordinary degree day basis and when calculated on the modified degree day basis—even though there is only a 2° F. difference between them. The calculations are made on the assumption that the system is subject to close thermostatic control with the heating responding quickly to changes in outside temperature. If a difference of 2° F. in the basis of calculation makes such a striking difference in heating costs, how much greater would be the difference in cost arising from less effectual methods of control or none at all?

TABLE 2. AVERAGE NUMBER OF DEGREE-DAYS FOR EACH MONTH BASED ON TEMPERATURE READINGS AT KEW OVER PERIOD 1921-1950

Month	No. of days	Mean temp., °F.	Degree-days for maintained temperatures as indicated							
			Egerton Committee formula*				Modified formula†			
			50°F.	55°F.	60°F.	65°F.	50°F.	55°F.	60°F.	65°F.
January ..	31	40·1	152	307	462	617	214	369	524	679
February ..	28	40·4	129	269	409	549	185	325	465	605
March ..	31	43·8	37	192	347	502	99	254	409	564
April ..	30	48·3	—	51	201	351	—	111	261	411
May ..	31	54·3	—	—	22	177	—	—	84	239
June ..	30	60·2	—	—	—	—	—	—	—	54
July ..	31	63·8	—	—	—	—	—	—	—	—
August ..	31	62·8	—	—	—	—	—	—	—	—
September	30	58·3	—	—	—	51	—	—	—	111
October ..	31	51·2	—	—	118	273	—	25	180	335
November	30	44·5	15	165	315	465	75	225	375	525
December	31	40·8	130	285	440	595	192	347	502	657
		Total ..	463	1,269	2,314	3,580	765	7,656	2,800	4,180

* 5° F. allowance for casual heating. † 3° F. allowance for casual heating.

TABLE 3 COSTS OF CONTINUOUS ELECTRIC HEATING FOR TYPICAL HOUSE

Air temperature maintained in house	Annual energy consumption	Degree-day basis			Annual energy consumption	Modified degree-day basis		
		Cost of electricity per kWh				Cost of electricity per kWh		
		0·75d.	1·0d.	1·1d.		0·75d.	1·0d.	1·1d.
°F.	kWh	£	£	£	kWh	£	£	£
65	52,000	163	217	239	60,800	189	252	277
60	33,500	104	139	153	40,600	127	169	186
55	18,400	58	77	85	24,000	75	100	110
50	6,750	21	28	31	11,100	31	41	45

The background of research (continued)

Domestic Heating in Practice; Temperatures and Seasonal Requirements

by E. Danter, M A, A Inst P. and J. B. Dick, M A, B Sc, A Inst P, A M I H V E, both of B R S

The authors begin by describing the results of the field tests carried out by BRS on occupied houses at Abbots Langley and relate these to the standards laid down in the Egerton Report. They find that the thermal inertia of a house makes the Egerton Report's prescribed room temperatures impossible to work to: they find also that people show no desire to maintain even temperatures throughout the heating season but "make do" with lower temperatures in cold weather. They then proceed to tabulate our knowledge of heat loss from different types of dwelling constructed to different standards of insulation and give the means for calculating the "heat balance" for most types of dwelling (but excluding the detached house) of 1,000 sq. ft. floor area.

Owing to the complexity of house heating, the *degree day* method used for factories and office blocks does not apply. Observations of houses in use and their temperature patterns led to the concept of the *typical seasonal average* heat requirements. Knowing the mean temperature which it is desired to maintain, it is possible to compute the heat loss and hence the input which will be required to maintain the balance at this required temperature.

One of the most important facts brought out by the BRS investigations was the differing thermal routine of different occupants: it was found, for instance, that different occupants in similar houses, using similar equipment, achieve fuel consumptions varying by as much as 15 per cent. and that the same occupants in the same house and using the same equipment use 10 per cent. more fuel when one type is used than another.

The Egerton report assumed certain temperatures for certain rooms at certain

times, *e.g.*, the living room was assumed to be 65° F. at certain periods of the day, 55° F. for the rest of the day and 50° F. overnight. It was found, however, that certain phenomena make these temperatures very difficult to realise. Heat transfer from nominally "heated" to nominally "unheated" rooms meant that the latter were kept at higher temperatures than were allowed for. Thus for appreciably more than half the season unheated bedrooms were well above the 50° F. recommended in the Egerton report. This interaction does not, of course, affect "whole house" heating.

Thermal Capacity

Another disturbing phenomenon was the effect of *thermal inertia*, both of structure and of heating system, which prevents any quick change from one design level to another. Thus the living room never cools to anything like the 50° F. recommended in the report. This means in practice that the *average temperature* is higher than was bargained for and the daily heat loss is higher in proportion: heat is stored during the heating period only to be lost at night. Further, thermal capacity prevents any precise control of temperature during the day. In fairness it must be pointed out that the framers of the Egerton Report recognised the part played by thermal capacity but, in the absence of facts, underestimated it. Its ascertained importance makes it clear that detailed temperature schedules are impracticable and it was found in practice that what mattered was the late evening temperature of the living room, the "9 p.m. value": this figure determines the *mean temperature* which the daily heat input must be able to maintain. In cold weather the overnight fall will be greater, with the result that for a given 9 p.m. value the "mean temperature" will be lower. Theoretically you would expect people to demand the same 9 p.m. temperature for comfort, but in practice they tend to make do with a lower temperature in cold weather. The reason for this is that most people are too lazy to bother to adjust the heating cycle as the weather changes.

Temperatures Attained

An important part of the Abbots Langley Experiment consisted of recording the actual temperatures achieved in the main rooms of the 36 sample houses. These are recorded in Table 1. It was found possible to divide

TABLE 1. TYPICAL SEASONAL INSIDE TEMPERATURES FOR MEAN OUTSIDE TEMPERATURES OF 32° AND 55° F.

	High	Medium	Low
Living-room	62–67	56–65	52–64
Dining-space	63–69	58–67	52–64
Parlour* ..	—	—	43–61
Kitchen ..	63–69	58–67	52–64
Bedroom ..	54–65	48–63	43–60
Bathroom ..	56–67	49–63	44–62
Hall ..	54–65	48–61	44–61
Landing ..	55–65	49–63	46–62
House mean	57–66	50–63	47–62

* Unheated.

the houses and their occupants into three categories: those where the standard of heating was consistently "high," those where it was "low" and a group midway between which could be classified as "medium." This breakdown did not correspond exactly with the use of different heating systems, but this was, of course, an important influence on the standard achieved. The lower reading in each column gives the inside temperature in the room when the outside temperature was 32° F., the higher figure when the outside temperature was 55° F. The difference illustrates very well the point that when it is cold outside people make do with a lower temperature within.

Special attention was given to the living rooms where certain interesting points were brought to light. Living room temperatures with solid fuel appliances were on average some 3°—4° lower than those of houses with "whole house heating." One reason for this may be that whole house systems require a higher temperature to offset the absence of a high radiation output (*i.e.* to maintain comfort conditions). Another may be that temperature readings were taken in the corners of the room—which are never heated so efficiently by a mainly radiative source. It was found also that higher average temperatures were maintained with automatic and semi-automatic equipment than when input is more consciously controlled and that higher daytime temperatures were realised with back-boilers, since occupants tended to stoke them up to maintain the hot water supply.

An interesting point on the bedrooms was the fact that "unheated" bedrooms were in practice only 1·6° F. cooler than those with background heating. This is because of heat gains from other rooms, the decisive factor (apart from insulation and window opening) being the temperatures maintained downstairs and the situation of the room on plan. It was found that each rise of 1° F. in the temperature of the living room produced a corresponding rise of 0·5° F. in bedrooms above if the house is of "medium" insulation (which is described shortly).

The *house mean temperature* was found by taking an average of all the temperatures of all the rooms, counting the living room twice over. The distribution of house mean temperature was found to correspond fairly closely to the three degrees of heating: the high standard being realized by "whole house" heating, the medium standard by "two-stage heating" (*i.e.*, background plus topping-up), and the low standard by "partial heating" (heating in certain rooms only). With a mean outside temperature of 43·5° F. it was found that the high standard produced a rise of 18° F., medium 13° F. and low 11° F.

Another investigation at Abbots Langley concerned the effect of the lower thermal capacity of lightweight construction on temperature and heat loss. Four houses were built of 12-in. no-fines concrete, four of concrete posts with 2-in. concrete cladding and lightweight lining, and there were four aluminium bungalows. Only the last of these showed any real difference in the temperature pattern and this was not substantial. In fact, the mean temperature difference in the bungalows was only some 5-10 per cent. lower than in traditional houses. The reason given for the relative insignificance of the effect of cladding is that the greater part of the heat stored in a house is stored, not in the walls but in the chimney breast, flues and solid floors. To obtain any advantage from low capacity construction, floors must be low capacity too, and the heating system must be highly flexible.

Heat Losses

Coming on to the question of the calculation of heat losses, and beginning with heat losses by conduction, it must first be noted that throughout the experiments the average transmittance throughout the winter has been taken rather than "U" value (*i.e.*, transmittance during days of greatest heat loss). "Average transmittance" is the same as "U" value for most constructions, but there are certain exceptions. Thus the "U" value for glass is 1·00, but the average transmittance is only 0·85 Btu which, when the frames of wood windows are taken into account, is nearer to 0·7 Btu. If curtains are taken into account it drops again to 0·6—not including solar gain through the glass.

In considering the question of conduction losses three standards of insulation were taken. The first, a "low" standard, corresponds with the traditional construction of the past and gives average thermal transmittance as follows:

Walls	9 in. solid brick	0·43
Floor	suspended timber	0·35
Roof	tiles on battens	0·42
Windows	curtained at night	0·60

The second, which corresponds to good average construction today, gives average thermal transmittances of:

Walls	11 in. cavity brick	0·30
Floor	solid concrete	0·20
Roof	tiles on battens (felted)	0·35
Windows	curtained at night	0·60

The third represents a hypothetical high standard for the future and reads:

Walls	incorporating added insulation	0·15
Floor	solid concrete	0·20
Roof	with insulated ceiling	0·10
Windows	curtained at night	0·60

By making use of a table prepared by Dr. Weston which gave the ratios of exposed wall, ground floor, roof and window areas, all to floor area, for six different dwelling types, it is possible to measure the conduc-

TABLE 2. RATIOS OF ENCLOSING AREAS TO FLOOR AREA

Plan type	Wall/floor	Ground floor/floor	Roof/floor	Window/floor
Semi-detached	1·0	0·5	0·5	0·19
Terraced ..	0·75	0·5	0·5	0·17
Flatted (ground floor) ..	0·75	1·0	0·0	0·15
Flatted (intermediate floor) ..	0·75	0·0	0·0	0·15
Flatted (top floor) ..	0·75	0·0	1·0	0·15
Detached (two-storey) ..	1·25	0·5	0·5	*

* Considerable variation.

tion losses (in Btu/hr./°F./sq. ft. floor area) for the various plan types. These (which exclude the detached house since this is so variable) are given in Table 3.

TABLE 3. CONDUCTION LOSSES FOR DIFFERENT PLAN-TYPES AND INSULATION STANDARDS (BTU/H/°F./SQ. FT. FLOOR AREA)

	Insulation standard		
	Low	Medium	High
Semi-detached	0·93	0·69	0·42
Terraced	0·82	0·60	0·36
Flatted (ground floor)	0·77	0·52	0·40
Flatted (intermediate floor)	0·42	0·31	0·20
Flatted (top floor)	0·84	0·66	0·30

Ventilation loss was the subject of experiment in the post-war study of house heating when the air-change rates were measured in occupied and unoccupied houses on one exposed and one sheltered site. It was found then that in winter the air-change rate in unoccupied semi-detached houses on the unsheltered side was 1·5 per hr. and that when the houses were occupied this rose to 2·5 per hr. On the sheltered site these were reduced to 1 and 2 air changes per hr. Since houses are normally sheltered it is suggested that 2 air changes per hr. is a normal figure.

One air change per hour for a dwelling with 8 ft. ceilings takes away 0·16 Btu/hr./°F. temp. difference/sq. ft. of floor area.

By putting the evidence of loss by ventilation with that of loss by conduction it is possible to give a table which will include the heat loss per heating season (expressed in Therms/°F. mean temperature difference) for dwellings of 1,000 ft. floor area, of the types listed in table 3, insulated to the three standards already described and with 1, 2 or 3 air changes.

TABLE 4. SEASONAL HEAT LOSS (THERMS/°F.) FOR DWELLINGS OF 1,000 SQ. FT. FLOOR AREA

	Insulation standard								
	Low			Medium			High		
Air changes per hour	1	2	3	1	2	3	1	2	3
Semi-detached	60	69	78	47	55	64	32	41	50
Terraced	54	63	72	42	51	59	29	37	46
Flatted (ground floor)	51	60	69	37	46	55	31	40	48
Flatted (intermediate floor)	32	41	50	26	35	43	20	29	37
Flatted (top floor)	55	64	73	45	54	63	25	34	43

Heat Inputs

In considering heat inputs account must be taken of the significant gains which are to be had from people's bodies, solar radiation, cooker and water heating, which in a heating season would come to about 25 therms.

Solar radiation, direct and diffused, has been measured at Kew and figures have been given for the amount striking vertical surfaces facing North, South, East and West and horizontal surfaces for the different months of the heating season. Adding a figure of 20 per cent. for sq. ft. per day for radiation reflected from the ground you get average daily radiations throughout the heating season as follows:

South facing wall	350 Btu/sq. ft.
East and West facing walls	210 Btu/sq. ft.
North facing wall	130 Btu/sq. ft.

and a mean radiation on all surfaces of about 230 Btu-sq. ft. 85 per cent. of this striking glass will reach the interior (*i.e.* 200 Btu/sq. ft.). In a semi-detached house the area of windows averages 0·19 times the floor area (Table 2). Therefore the solar gain during the heating season of such a house of 1,000 sq. ft. would be about 70 therms.

Of the solar heat striking walls some 40 per cent. will be reflected. With a house of medium insulation about one-tenth of the remaining 60 per cent. will get in, so that the gain during the heating season of the kind of house we are considering is likely to be about 15 therms.

It is interesting to notice that measurements of the actual temperature rise produced by solar heat alone in unheated, unoccupied houses at BRS confirmed the Kew figures.

To body and solar heat must be added the incidental input from lighting—which is put at 10 therms from cookers, 60 therms for gas and 35 therms for electric cookers and from water heating. This last is a most difficult factor to calculate. The most recent evidence we have on this comes from an experiment by F. J. Eaton using a small independent boiler with short unlagged flow and return pipes to a lagged indirect cylinder. It was found that 26 per cent. of the thermal content of the fuel was given off as radiation and convection from the boiler, 44 per cent. was delivered into the water circuit. Of the 44 per cent. which went into the water, 25 per cent. was accountable to the water draw-off. Therefore the remaining 19 per cent. was given off by pipes and cylinder. Therefore the total space heating output was 26 per cent. plus 19 per cent., *i.e.* 45 per cent.

The correct concept to use when assessing input from "official" space heating is that of "house efficiency." "House efficiency" is the total heat delivered to a house from a heating installation divided by the thermal content of the fuel burned. Estimated house efficiencies for different fuels and different appliances as given in the Ridley report are set down in Table 5.

TABLE 5. ESTIMATED HOUSE EFFICIENCIES (FROM RIDLEY REPORT)

Inside flue—heating for 5 hours or more.

	per cent.
1. Electric fire	100
2. Gas fire	
(*a*) Radiant	50–60
(*b*) Convector	60–70
3. Closed stove burning coke	65–75
4. Openable stove	
(i) Burning coke	55–65
(ii) Burning coal	45–55
5. Improved open fire, with restricted throat	
(*a*) Convector	
(i) Coke	55–65
(ii) Coal	45–55
(*b*) Non-convector	
(i) Coke	50–60
(ii) Coal	40–50
6. Improved open fire, without restricted throat	
(*a*) Convector	
(i) Coke	50–60
(ii) Coal	40–50
(*b*) Non-convector	
(i) Coke	45–55
(ii) Coal	40–50
7. Stool-bottom grate with front fret	35–45

Recent work in calorimeter rooms at the Fuel Research Station show that house efficiencies can show a very considerable advance on test-bed efficiencies. Thus the test-bed efficiency of an inset open fire burning coal is 25 per cent. but added heat gains from the surround and chimney breast raise this to about 30 per cent.; with an internal flue a further 3—4 per cent. is accountable to heat given off the back of the setting and 14 per cent. more may be recovered from 10 ft. length of a traditional flue. Thus the "house efficiency" is at least 40 per cent.

Heat Balance

One of the chief points of interest about the Abbots Langley experiments was that they gave an opportunity for testing how far calculations based on the data discussed here prove accurate in practice. The houses are semi-detached, with a seasonal heat loss per degree of 46 therms. House 16 (to take one example) was equipped with full central heating by radiators, with electric cooking. The solid fuel input for the winter of 1949-50 was 878 therms. This method has a house efficiency of 70 per cent. and therefore should give a heat input of 615 therms. Electrical consumption was 42 therms, body heat was calculated at 25 therms, solar gain at 85 therms, giving a total estimated input of 767 therms. This should have given an average temperature difference of 16·6° F. In fact the observed difference was 18·1° F. House 34, which has an open fire with back boiler serving a lagged tank, with gas cooking, gave estimated temperature differences for the three winters 1947-50 of 9·4° F., 9·4° F. and 9·0° F. and observed values of 8·5° F., 11·1 ° F. and 9·2° F.

If it is accepted that these results show reasonable accuracy, we may use the various tables to calculate full inputs required for houses which fall within the categories described. Take, for example, a semi-detached house of 1,000 sq. ft. with good insulation which is to be centrally heated to maintain a temperature difference of 18° F. during the heating season. From Table 4 it may be estimated that the seasonal loss will be 740 therms. The miscellaneous heat inputs—body and solar heat, gas cookery and lighting—would come to a total of 170 therms, leaving 750 therms to be supplied by the heating system. At 75 per cent. house efficiency the fuel input required would be 800 therms, corresponding to just over 3 tons of solid fuel. The importance of fuel efficiency and good insulation can be seen when we reflect that this amount of fuel used in the same house with only medium insulation, and with heating by an open back-boiler (*i.e.* 40 per cent. efficiency), would produce a temperature difference of only about 9° F.

The background of research (continued)

Structural Insulation and Heating Systems—Values and Capital Costs

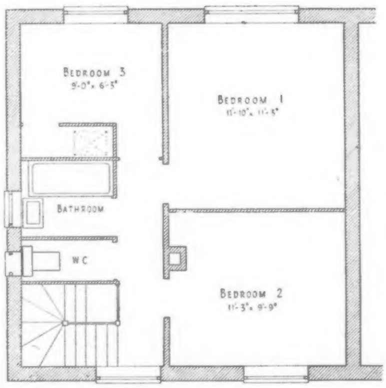
by H. F. Broughton and G. D. Nash, A R I B A, T P Dip, both of B R S

Danter and Dick, in the previous paper, were concerned with the amount of fuel needed to produce certain indoor temperatures throughout a heating season. The authors of this paper are concerned, not with temperatures or the efficiency of fuels, but with the capital cost of different standards of insulation and of different heating methods. They begin by taking a very ordinary semi-detached house and setting down in detail the additional cost of raising its overall insulation from the present " post-war " standard to two improved levels. They then cost nineteen different ways of providing space and water heating to this house by conventional means and fifteen different ways using " specialist installations." The first range from £167 to £268, the second from £360 to £630. They conclude with brief references to multi-storey buildings which suggest that the balance of cost is about the same.

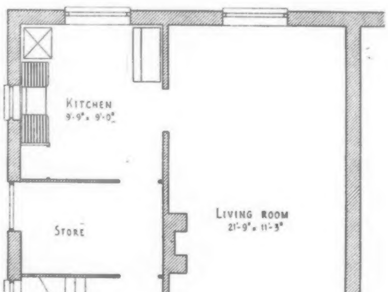
Before 1932 U values, which are the only yardstick available to builders and architects for comparing the thermal properties of wall, floor and roof construction, were either computed from a knowledge of conductivity values of materials or were based on measurements of the conductance of composite panels, carried out under laboratory conditions. Determinations of U values under actual conditions of exposure were begun at the Building Research Station for pitched roofs in 1932 and for walls in 1936. In addition measurement of the thermal conductance of a window was made during the winter of 1935-36. No measurements have yet been made in this country for floors and flat roofs.

Subsequent field tests have shown that actual rates of heat loss may vary considerably from the calculated U values. A case in point is that of windows. Though the accepted U values of 1·00 for single glazing and 0·5 for double glazing are appropriate for calculating the maximum heat demand of a building (*i.e.* for calculating the maximum required output for a heating plant) they are high for determining the building's seasonal heat loss. W. G. Marley's investigations (1936) which took into account only conductance at *night* when there was no solar radiation to interfere, showed an average value for single glazing of 0·85. Further, investigations of 1946 into heat loss through north facing windows gave a daily average U value for a single-glazed uncurtained wood window (*i.e.* including the frame) of about 0·60: when curtains were drawn this figure was further reduced to 0·48 for light and 0·43 for heavy curtains. Double glazing would reduce this further as it provides added resistance to outward heat flow and virtually none to inward solar radiation.

On the other hand, preliminary investigations on light-weight wall claddings show that heat flow on these may be greater than calculated U values would suggest. One example, a metal-framed wall panel, covered externally with sheet metal and internally with hardboard with an insulant in the cavity giving a calculated U value of 0·18, showed an actual average winter U value of 0·33 and a highest weekly average of 0·42.



First floor plan



Ground floor plan

Fig. 1. Plans of typical semi-detached house on which the authors' figures of capital costs have been based.

House U Value

In order to estimate the effect of thermal insulation on building it is necessary to take a characteristic house and to take as a starting point familiar methods of construction. The house chosen is semi-detached with a plan as given in Fig. 1 and it is assumed to be built to the four different standards of insulation described in Table 1. In order to provide a basis of comparison it is necessary to use a concept described as " House U " value and which is arrived at as follows:

In the type house in question the areas of the bounding surfaces were made up of external brickwork (excluding party wall), 840 sq. ft. (4/9ths), ground floor (without external walling 453 sq. ft. (2/9ths), uppermost ceiling 453 sq. ft. (2/9ths), windows and external doors 220 sq. ft. (1/9th).

The U value of each of these elements is then divided by the fraction of the total bounding surface which it represents and the totals are added togther to give the " House U " value. This " House U " value differs in two respects from the concept used by Dick and Danter in their paper on " Domestic Heating in Practice " (summary on page 738). First Dick and Danter were concerned with seasonal average heat requirements, whereas U values relate to *maximum heat requirements;* second, Dick and Danter's conduction losses were expressed as Btu/hr./deg. F. per *square foot of floor area,* not as an average figure for all bounding surfaces.

TABLE 1.

(a) Pre-war House:	
9-in. brick walls	$U = 0{\cdot}43\ (U \times 4/9 = 0{\cdot}191)$
Suspended timber floor	$U = 0{\cdot}40\ (U \times 2/9 = 0{\cdot}089)$
Tiled roof on battens	$U = 0{\cdot}56\ (U \times 2/9 = 0{\cdot}124)$
Windows and doors	$U = 1{\cdot}00\ (U \times 1/9 = 0{\cdot}111)$
	" House U " value = 0·52
(b) Post-war House:	
11-in. brick cavity walls	$U = 0{\cdot}30$
Solid ground floor (with tile finish)	$U = 0{\cdot}20$
Tiled roof on battens and felt	$U = 0{\cdot}43$
Windows and doors	$U = 1{\cdot}00$
	" House U " value = 0·38
(c) Future House:	
(i) Walls	$U = 0{\cdot}15$
Floor	$U = 0{\cdot}20$
Roof	$U = 0{\cdot}10$
Windows and doors	$U = 1{\cdot}00$
	" House U " value = 0·24
(ii) Walls	$U = 0{\cdot}15$
Ground floor	$U = 0{\cdot}15$
Roof	$U = 0{\cdot}10$
Windows and doors	$U = 0{\cdot}50$
	" House U " value = 0·18

Costs

In order to assess the cost of the various improvements suggested it is assumed that work was being carried out as part of a contract for 50 semi-detached houses in the outer London region. The main interest lies in the additional expenditure required to obtain the standards of insulation described in sub-section (c) of Table 1.

To take walls first, the U value of approximately 0·15 can be obtained by making the following additions or substitutions to the 11-in brick cavity external wall in item (b).

	estimated extra cost per house
(i) Filling wall cavity with suitable loose fill (though contrary to accepted practice, initial tests show that it could prove satisfactory, granted precautions in building)	£26
(ii) Lining internal face of inner leaf	
with 1 in. corkboard slabs	£95
with 2 in. woodwool slabs	£75
(iii) Fixing battens to the internal face of inner leaf and covering with a flexible insulant and a board lining	£67
(iv) Substituting inner leaf of 6 in. low conductivity light weight concrete blocks for the 4½-in. brick inner leaf	£51
(v) Substituting 4-in. suitable lightweight concrete blocks for 4½-in. brick inner and outer leaves	£45

To these may be added two further possible constructions for the future: a 10 in. large perforated brick known as B25 now manufactured in Switzerland which alone gives a U value of 0·17, and a cavity wall comprising an outer loadbearing brick leaf with piers and an inner leaf of 3 in. woodwool slabs which gives a U value of about 0·15.

A ground floor U value of 0·15 can be obtained:

(*i*) by adding a wood block finish to a solid ground floor at an estimated extra cost (*i.e.* over a plastic tile finish) of £69;
(*ii*) by draping 1 in. quilt below a suspended timber floor at an extra cost of £17.

A roof value of 0·10 can be obtained by filling the spaces between ceiling joists with an insulant 2-4 in. thick according to its conductivity at an extra cost of about £9.

A window U value of 0·50 can be obtained by using double glazing, the extra cost of which is as follows:

For factory-made, hermetically-sealed, double-glazing units in single wood frames (development suggests that this price may be reduced)	£85
For standard wood, double windows, weather-stripped	£100
For special pivot-hung wood double windows, weather-stripped	£188

The upshot of this is that the type house in question can be raised to the standards laid down in (*c*) at the following costs:

1. with a solid floor

	house U value 0·24	*house U value* 0·18
	£	£
walls	26	26
solid ground floor	—	69
roof	9	9
windows	—	85
	£35	£189

2. with a suspended floor

	house U value 0·24	*house U value* 0·18
	£	£
walls	26	26
timber floor	17	17
roof	9	9
windows	—	85
	£52	£137

These totals represent the extra cost of raising the standard of insulation of the average post-war house to "house U" values of 0·24 and 0·18; but it must be remembered that the tendency of fuel prices to go up and of the purchasing power of money to go down make the benefits of this extra capital expenditure even more worthwhile.

HEATING SYSTEMS

In considering the cost of heating systems it is essential to take into account all builders' work and to consider all the space and water heating in a house as a whole, since it is only possible by this means to give comparable figures for installations in which space- and water-heating is given by one appliance. Further it has been decided to class installations as "conventional" or "specialist." The former are those consisting of open fires, stoves, small independent boilers, grates, gas and electric points and heaters: the latter are those for which a specialist designer or contractor is normally employed.

In computing the costs given in the tables which follow, strict account has been taken of the actual plans under consideration (see Fig. 1). Thus the cost of a chimney breast and flue includes for appropriate foundations and roof flashings, but makes allowance for the fact that the breast serves as a partition wall to the room. Thus deduction has been made of the cost of building a partition wall in the gap which its absence would leave. Costs for specialists' work were made up from tenders submitted by appropriate specialists and builders' costs priced in the usual way.

Another difficulty arose from the fact that "specialist" and "conventional" installations do not provide necessarily-equal services, either qualitatively—which, of course, cannot be assessed here—or quantitatively. It was decided, therefore, that both types should be capable of providing 65° F in the living room, 60° F in the kitchen and 55° F in the hall and bedrooms when the outside temperature is 30° F, and that in addition they should heat a 30 gal. domestic hot water cylinder and a towel rail in the bathroom.

The U values assumed for the houses were as follows:

External walls	0·25
Ground floor (living room)	0·15
Ground floor (except living room)	0·20
Roof	0·15
Windows	1·00

It was assumed that no heat would be lost through the party walls and that ventilation rates would provide two air changes per hour for the living room, kitchen, hall and stairs and 1¼ for the upstairs. Costs of appliances are their purchase price to the builder or to the specialist.

The Tables, therefore, are composed as follows:

Table 2 gives the estimated costs (including builders work) of the various pieces of equipment commonly used in "conventional" installations; Table 3 gives examples of nineteen of the more usual combinations of these items; Table 4 gives the estimated costs of these nineteen combinations. This last includes, where necessary, charges made by Electricity and Gas Boards for providing their service, for carcassing and for wiring: it includes also the cost of providing fuel stores (one for each appliance used).

TABLE 2.
ESTIMATED COSTS OF ITEMS IN "CONVENTIONAL INSTALLATIONS" FOR TWO-STOREYED HOUSES, INCLUDING COSTS OF BUILDERS' WORK, APPLIANCES, ETC.

(The purchase prices to the builder of selected appliances, fittings, etc., are shown in parentheses.)

Item No.	*Description*	£ s. d.
1.	Internal chimney breast and single-flue stack (including foundations) for living-room fire; in common brickwork rendered and set in plaster, stack in facing bricks, lead flashings and apron, chimney cap	28 10 0
2.	Single flue and stack (including foundations) for domestic boiler in kitchen; in common brickwork, rendered and set in plaster, stack in facing bricks, lead flashings and apron, chimney cap	18 10 0
3.	As item 2, but flue corbelled out from external wall at height of 6 ft. from ground floor level	17 0 0
4.	Chimney breast and double-flue stack (including foundations) for living-room fire and domestic boiler; in common brickwork rendered and set in plaster, stack in facing bricks, lead flashings and apron, chimney cap..	38 0 0
5.	Additional cost to items 2, 3 or 4 for lining domestic-boiler flue with glazed pipes and providing drip tray	3 0 0
6.	Galvanized cold-water storage tank and ball valve (£6 12s. 3d.), 25-gal. copper direct cylinder (£9 17s. 8d.), insulating jacket (£3 16s. 6d.), copper flow and return pipes, cold feed to cylinder, hot and cold draw-off pipes to fittings. (Connecting flow and return pipes to the boiler are included in this item but not in the later items for back boilers and independent boilers)	50 0 0
7.	Additional cost to item 6 for substituting for the direct, a 25-gal indirect copper cylinder (£11 13s. 7d.) and combined primary feed and expansion pipe in copper	5 0 0
8.	30 in. × 16 in. wall panel radiator (£1 17s. 6d.) of approx. 8 sq. ft. heating surface in kitchen, valve, brackets, copper feed pipes and fittings	6 10 0
9.	30 in. × 16 in. wall panel radiator (£1 17s. 6d.) in hall, valve, brackets, copper feed pipes and fittings ..	7 0 0
10.	32 in × 30 in. floor radiator (£4 12s. 2d.) of approx. 20 sq. ft. heating surface in bedroom, valve, copper feed pipes and fittings ..	10 10 0
11.	16-in. open fire with gas ignition (£4 5s.) for living room, tiled surround and hearth (£5 16s. 1d.) ..	15 10 0
12.	16-in. open fire with back boiler and gas ignition (£8 16s.) for living room and domestic hot water, tiled surround and hearth (£5 16s. 1d.) ..	20 0 0
13.	16-in. open fire with back boiler and gas ignition (£13 5s. 8d.) for living room and domestic hot water and one or two radiators, tiled surround and hearth (£5 16s. 1d.)	25 10 0

Item No.	*Description*	£ s. d.
14.	16-in. open fire with back boiler and gas ignition (£15 16s. 6d.) for living room and domestic hot water and three radiators, tiled surround and hearth (£5 16s. 1d.)	28 10 0
15.	Openable stove (£19 1s. 6d.) for living room, tiled surround and hearth (£5 16s. 1d.)	33 0 0
16.	Openable stove with back boiler (£22 5s. 9d.) for living room and domestic hot water, tiled hearth and surround (£5 16s. 1d.) ..	36 10 0
17.	Openable stove with back boiler (£28 16s. 6d.) for living room and domestic hot water and one radiator, tiled hearth and surround (£5 16s. 1d.)	44 0 0
18.	Openable stove with back boiler (£28 12s.) for living room and domestic hot water and two radiators, tiled hearth and surround (£5 16s. 1d.)	44 0 0
19.	Closed stove (£16 15s. 3d.) for living room, tiled hearth and surround (£5 16s. 1d.)	30 0 0
20.	Independent boiler (12,000 Btu.) (£10 12s. 9d.) and smoke pipe for kitchen and domestic hot water ..	17 0 0
21.	Independent boiler (15,000 Btu.) (£12 19s. 3d.) and smoke pipe for kitchen and domestic hot water and one radiator	19 10 0
22.	Independent boiler (18,000 Btu.) (£14 12s.) and smoke pipe for kitchen and domestic hot water and two radiators	21 10 0
23.	Independent boiler (21,000 Btu. minimum) (£18 19s. 9d.) and smoke pipe for kitchen and domestic hot water and three radiators	26 10 0
24.	Free-standing open fire (£10 12s. 9d.) for living room, tiled surround and hearth (£5 16s. 1d.)	23 0 0
25.	Fuel store, 4 ft. × 3 ft. × 7 ft. high, with concrete slab, 4½ in. common brickwork, concrete roof, retaining boards and door (based on Coal Utilisation Council's designs) ..	18 0 0
26.	Double fuel store, with two compartments each 4 ft. × 3 ft. × 7 ft. high and built as item 25	33 0 0
27.	Precast concrete single flue for gas fire in living room, with concrete terminal and flashings above pitched roof ..	11 0 0
28.	As item 27 but for gas fire in bedroom	9 0 0
29.	The two gas-fire flues in items 27 and 28 combined into one stack.. ..	19 0 0
30.	Gas carcassing to five or more points (the charge by a Gas Board assumed to be £6 inclusive of 30 ft. length of service pipe from the footway) ..	7 10 0
31.	Gas fire (£12 18s. 5d.) for living room, tiled surround and hearth (£5) and connection to gas point	22 10 0
32.	Wall panel gas fire (£8 0s. 11d.) for bedroom and connection to gas point	10 10 0
33.	Gas sink heater (£12 8s.) including connections to gas point and water supply	16 10 0
34.	Gas water-storage heater, under-draining board type (£32 14s. 4d.), cold feed, expansion pipe, hot and cold feeds to fittings, cold-water storage cistern and ball valve, connections to gas point	64 0 0
35.	Multipoint gas water heater (£32 2s. 8d.) vent, cold feed, hot feed to fittings, valves and connection to gas point but excluding cold-water storage cistern. (This item is intended for an auxiliary or summer domestic water-heating service—see also item 36.)	47 10 0
36.	Multipoint gas water heater (£32 2s. 8d.), vent, cold-water storage cistern and ball valve, cold feed, hot and cold feeds to fittings, valves, and connection to gas point. (This item is intended for the main domestic water-heating service throughout the year—see also item 35.)	64 10 0
37.	13-amp. electric point, on ring main system, with outlet socket, and plug (assuming approximately 10 points per house)	3 0 0
38.	2-kW electric wall panel fire (£5 4s. 2d.), in bedroom, including electric point and connection to same	9 10 0
39.	3-kW immersion heater with thermostatic control (£5 18s. 2d.), electric point and connection to same ..	10 10 0
40.	1½-gallon, 750-watt electric sink water heater (£13 6s. 4d.), electric point and connection to same and to water supply	19 0 0
41.	Electric under-drainage-board water heater (£38 0s. 10d.), cold feed, expansion pipe, hot and cold feed pipes and fittings, cold-water storage cistern and ball valve, electric point and connection to same	71 10 0
42.	Solid-fuel cooker with boiler for domestic hot water (£34 6s. 4d.) ..	51 0 0
43.	Back-to-back grate with boiler for domestic hot water (£36 11s. 5d.), tile surround and hearth (£5 16s. 1d.)	57 0 0
44.	Gas convector heater for floor or wall mounting (£3 16s. 5d.) and connection to gas point	5 10 0
45.	Gas back-boiler unit (£2 16s. 5d.) and flexible connection to gas point ..	3 10 0
46.	30 in. × 36 in. chromium-plated 2-rail towel rail (£5 16s. 5d.) connected to hot-water circulation	10 10 0
47.	Electrically-heated towel airer (£7 1s. 3d.), electric point and connection to same	11 10 0

Notes.—(i) In the heating installations given in Tables 2, 3 and 4, the cost of providing cooking facilities is not included. Items 42 and 43 above include for cooking, and a suitable allowance should therefore be made in using either of these items. A reasonable cost for the provision and installation of a gas or an electric cooker is £25—£40.

(ii) The heat output given above for independent boilers is the rated output at 6,000 Btu./h. per sq. ft. of boiler heating surface. The "catalogue rated output" is based on 10,000 or 11,000 Btu./h. per sq. ft.

(iii) In the items above dealing with stoves and free-standing fires, tile surrounds and chimney breasts, as used for normal open fires, have been assumed. Suitable recesses or other settings may be designed for these appliances.

The costs of "conventional" installations given in Table 4 are interesting, as their general order and extent is not always appreciated, since the present system of drawing up bills of quantities includes parts of these costs in different trades. It is also interesting to note that they range from £167 to £268 and account for 10-15 per cent. of the total cost of the house. The costs of "specialist" installations are given in Table 5. They are further described in "*Central Heating Systems*" by H. H. Bruce summarised elsewhere. It will be noted that the cost of "specialist" installations with solid fuel ranges from £360 to £465 and that if these are heated by oil the extra cost is £165, bringing the range up to £525-£630. Also that electric embedded floor heating at £310 is the cheapest of the "specialist" installations. Nevertheless, the cost difference between conventional and specialist installations is still considerable.

TABLE 3 EXAMPLES OF COMBINATIONS OF HEATING APPLIANCE FOR "CONVENTIONAL INSTALLATIONS" IN TWO-STOREY HOUSES.

Example No.	*Living room*	*Hall*	*Kitchen*	*Bedroom 1*	*Bedroom 2*	*Bedroom 3*	*Summer water-heating*	*Cylinder*
1	Open fire, gas ignition	Nil	Independent boiler	Elec. panel fire	Elec. panel fire	Elec. point	Elec. immersion heater	Direct
2	Do. do.	Do.	Do.	Gas panel fire	Gas panel fire	Do.	Gas multipoint heater	Do.
3	Free-standing open fire, gas ignition	Do.	Do.	Elec. panel fire	Elec. panel fire	Do.	Elec. immersion heater	Do.
4	Do. do.	Do.	Do.	Gas panel fire	Gas panel fire	Do.	Gas multipoint heater	Do.
5	Open fire, back boiler, gas ignition	Do.	Nil	Elec. panel fire	Elec. panel fire	Do.	Elec. immersion heater	Do.
6	Do. do.	Do.	Do.	Gas panel fire	Gas panel fire	Do.	Gas multipoint heater	Do.
7	Openable stove, back boiler	Do.	Do.	Elec. panel fire	Elec. panel fire	Do.	Elec. immersion heater	Do.
8	Do. do.	Do.	Do.	Gas panel fire	Gas panel fire	Do.	Gas multipoint heater	Do.
9	Open fire, back boiler, gas ignition	Do.	Radiator	Elec. panel fire	Elec. panel fire	Do.	Elec. immersion heater	Indirect
10	Do. do.	Radiator	Do.	Do. do.	Do do.	Do.	Do. do.	Do.
11	Do. do.	Do.	Do.	Radiator	Do. do.	Do.	Do. do.	Do.
12	Openable stove, back boiler	Nil	Do.	Elec. panel fire	D. do.	Do.	Do. do.	Do.
13	Do. do.	Radiator	Do.	Do. do.	Do. do.	Do.	Do. do.	Do.
14	Open fire, gas ignition	Do.	Independent boiler	Do. do.	Do. do.	Do.	Do. do.	Do.
15	Do. do.	Do.	Do.	Radiator	Do. do.	Do.	Do. do.	Do.
16	Do. do.	Do.	Do.	Do.	Radiator	Do.	Do. do.	Do.
17	Free-standing open fire, gas ignition	Do.	Do.	Elec. panel fire	Elec. panel fire	Do.	Do. do.	Do.
18	Do. do.	Do.	Do.	Radiator	Do. do.	Do.	Do. do.	Do.
19	Do. do.	Do.	Do.	Do.	Radiator	Do.	Do. do.	Do.

TABLE 4. ESTIMATED COSTS OF THE EXAMPLES OF "CONVENTIONAL INSTALLATIONS" FOR TWO-STOREYED HOUSES AS SET OUT IN TABLE 2

Example No.	Estimated cost £	Example No.	Estimated cost £
1	204	10	191
2	261	11	195
3	211	12	195
4	268	13	202
5	167	14	218
6	224	15	221
7	176	16	227
8	240	17	226
9	184	18	229
		19	235

TABLE 5.

ESTIMATED COSTS OF "SPECIALIST INSTALLATIONS" INCLUDING COSTS OF BUILDERS WORK, APPLIANCES, ETC.

(The purchase prices to the specialist of selected boilers etc., are shown in parentheses.)

	£	£
(1) Hot-water radiator system with:— solid-fuel boiler and regulator (£43); radiators below windows on external walls to both floors; pipe runs exposed in rooms ..	385	
OR with semi-automatic oil burner ..		550
(2) Hot-water radiator system (close-coupled) with:— solid-fuel boiler and regulator (£43); hospital type radiators on internal walls to both floors	360	
(shelves over radiators not included)		
OR with semi-automatic oil burner ..		525
(3) Hot-water skirting heating panels (to both floors) with:— solid-fuel boiler and regulator (£43); circulating pump (£35); allowance for variation to normal skirting work	465	
OR with semi-automatic oil burner ..		630
(4) Hot-water embedded floor-heating panels with:— (*a*) Solid-fuel boiler and regulator (£45); circulating pump (£35); blender (£25); ⅜-in. soft copper tube embedded in ground floor; radiators to first floor; allowance for extra thickness of ground-floor screed	460	
(*b*) As (*a*) but without radiators on first floor and with smaller boiler (£36)	400	
(*Note*.—The design temperature of 55° F. in bedrooms will not be achieved in (*b*).)		
(5) Hot-water embedded ceiling heating panels with:— solid-fuel boiler and regulator (£45); ceiling panels in living room, kitchen and landing; floor panel in hall; allowances for pugging and special plastering to panels, insulation above ceiling panels, strengthening ceiling joists near panels, extra screed in hall	395	
(*Note*.—Design temperature for bedrooms is 50° F., and for the hall 60° F. in lieu of 55° F.)		
(6) Hot-water hollow-ceiling heating panels, as (4) but without pugging and special plastering	385	
(7) Ducted warm air with:— solid-fuel heat unit; gas circulator; ducts in ground and first floor ..	420	
OR with oil-fired heat unit		555
OR with gas-fired heat unit and electric immersion heater		425
(*Note*.—For the three installations in (7), the design temperature is 70° F. throughout the whole house.)		
(8) Electric embedded floor heating with:— (*a*) Electric cable in housing tubes in ground and first floors; extra thickness of ground-floor screed; insulation below cables in first floor	300	
(*b*) As (*a*) but without first-floor cables		190
(*Note*.—The design temperature of 55° F. in bedrooms will not be achieved in (*b*).)		

Capital Costs for Heating Installations in Flats

No comparable investigations have been made into the capital cost of heating installations in blocks of flats. A few random examples are given here which suggest that the balance of cost as between "conventional" and "specialist" installations is similar. The first example is that of three schemes built recently by a local authority in the London area with back-boiler conventional installations in each dwelling. Figures for these are given in Table 6.

The same authority estimate costs for two further schemes not using solid fuel as follows:

Scheme i: Balanced flue gas convector heater, electric wall panel fire with surround, gas multipoint balanced flue water heater	£100
Scheme ii: As scheme i but using electric embedded floor heating (4kW) in place of gas convector	£110

For the specialist installations there are two examples. The first consists of two identical ten-storey flats built in London in 1951 with a total of 94 flats heated by a central solid fuel boiler sited under one block. The average cost per flat was about £200, of which approximately one-third was accountable to builders work.

The second example consists of the estimates for a mixed development scheme of a total of 232 dwellings in the Midlands. Here the cost of solid fuel boilers and boiler house—which incidentally serve three laundries in addition—and of radiators and calorifiers in each flat (but *not* including the attendant builder's work) works out at an average of £200 per dwelling.

TABLE 6.

Items of builders' work	Costs per flat or maisonette: 3-storey block (with maisonettes) (pitched roof and flue liners)	4-storey Block (flat roof and parged flues)	7-storey block (flat roof and flue liners)
	£	£	£
(*a*) Breast, flue and stack ..	47	40	40
(*b*) Back-boiler fire and surround	15	12	12
(*c*) Fixing (*b*) above; hot-water installation including cylinder, and pipework and cold-water supply to same, labour and materials ..	58	46	82
(*d*) Gas point ..	2	2	2
(*e*) Two electric points ..	5	5	5
(*f*) Fuel store ..	12	12	12
Approx. total per flat	140	120	150

2 *appliances and systems*

Domestic Heating Appliances Fired by Solid Fuel; Open Fires, Stoves and Cookers

by F. J. Eaton, Ph D, B Sc, M Inst Gas E, A R I C, Deputy Manager, Watson House, and S. Stephens, Solid Fuel Development Manager, Radiation Ltd.

This is the first of two papers on fires, stoves and cookers, and is concerned throughout with the test bed efficiencies of each main variety of appliance. While commenting on the triumph of the stand-in open convector fire over the stool bottom grate in recent BCURA field tests, the authors point out that no further improvement of the open fire can be expected until it is made independent of the traditional fireplace opening. They consider that the traditional chimney is too big and that pargetting forms an unsuitable lining; that appliances must be so designed that they can become the property of the tenant; that we must devise a convention for rating stoves and must give up the dual space/water heating appliance.

The use of so many different criteria for testing the efficiency of appliances makes their assessment difficult. We have two kinds of *test-bed efficiency*, "cold-to-cold" and "flying start": we have "*working*" *efficiency*, defined in the Simon Report as "the ratio of the heat usefully employed when the fuel is used in an appliance under average conditions to the thermal equivalent of the energy or fuel delivered to the appliance": we have *continental efficiency* which is assessed by subtracting the percentage of heat in the escaping gases and ashpit loss; we have *system or house efficiency* used by BRS in the Abbots Langley trials; and we have *room heating efficiency* which debits an appliance with heat loss through air flow in excess of 2,000 cu. ft. per hour.

The limitation of test-bed efficiencies, which have to be used in this article, is that they do not represent a quantitative measure of the overall efficiency in the home. The only way this measure can be obtained is by field tests such as those recently carried out by BCURA in comparing stool

TABLE 1.

CHIMNEY VENTILATION CONTROL—APPROVED OPEN FIRE BURNING COKE

	Restricted throat			Unrestricted throat		
	Cu. ft./h.		Throat area, sq. in.	Cu. ft./h.		Throat area, sq. in.
	Maximum	Mean		Maximum	Mean	
Laboratory test	5,000	4,300	10½	11,800	9,000	94
Domestic test:						
Room closed ..	5,800	4,400	10½	8,100	5,700	68
Windows open	7,000	5,800	10½	14,000	10,700	68

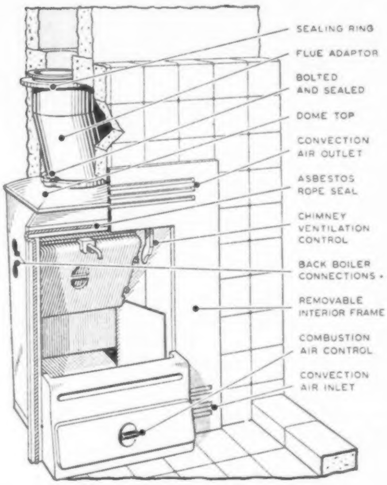


Fig. 2. Built-in convector open fire.

bottom grates and approved open fires. These showed that the latter not only saved 21 per cent. in fuel over the former but were operated to give longer periods of burning and to maintain higher levels of comfort. In other words the use of a more efficient appliance resulted in a change in the pattern of domestic usage. In practice it seems that two tests are required: a laboratory test to sort out the good and sub-standard appliances of each class and a field test to determine the practical fuel economics in use of different systems of heating or classes of appliance—not of the different appliances in each class.

Open Fire Appliances

The first type of open fire appliance to be considered is the *"stand-in" convector open fire* which is designed to stand into the existing fireplace opening without the need to remove the fire back. Of these "stand-in" fires there are two versions: one has a double casing and discharges warm air clear of the fireplace opening (see Fig. 1); the other has a single casing only and uses the existing fire back as an outer casing. The latter depends for its efficiency on an effective seal round the flue spigot and between the space enclosed by the fire back and the chimney. Test bed data for these fires show overall efficiencies of from 32·6 per cent. to 37·2 per cent., but it must be noted that no credit has been added for the control of ventilation which these fires give. Also it is worth noting that efficiency can be raised by about 2 per cent. by adding insulation behind the fire back. Further development of the stand-in type of convector is prevented by the form of the traditional fireplace opening. This does not apply to the version which stands *in front* of the opening—a form which used to be popular and which is now returning to favour. Much of the advantage of the stand-in convector over the open fire is due to convection, but much is also due to the control of the ventilation rate at about 2,500 cu. ft. per hour. This is about half the ventilation that the open fire must have to operate without smoking. Nevertheless, much can be done to improve the efficiency of the open fire by incorporating a chimney ventilation control device. The traditional fireplace has an area of 65 sq. in. but 12 sq. in. is generally enough to clear the products of combustion provided 30 sq. in. can be given when the fire is lit or refuelled. The immense difference in ventilation rates due to throat restriction can be seen in Table 1. Further tests have shown that they raise room temperature by 2°—3° F., an important gain for the expenditure of only £1 or so.

The *built-in convector open fire* (see Fig. 2) was introduced about 1943 and has been much used on housing estates in the London area. The fire is normally placed between kitchen and living room, the latter being heated by direct radiation from the fire, the former by air circulation round the outside of the appliance. Further, there is a back boiler, and convection warm air is discharged into two upstairs bedrooms. Test data show overall efficiencies of 55 per cent.—57 per cent. It is now considered better not to attempt to heat the bedrooms, but to divert all convected air to either kitchen or living room. Another point to be noticed by architects is that the dimensions of different makes have not been standardized and that it is therefore necessary to choose the appliance before dimensioning the surround. The dimensions of the adaptor pipe depend not only on the height of the appliance and the position of the flue but on the thickness of any tiled surround that may be specified. It is doubtful if building-in is worth it.

The main purpose of the *down-draught open fire* is to reduce smoke. This it does more efficiently when it is operating at high than at low rates of combustion. Typical test bench performances show an overall efficiency of 48·7 per cent. burning coal and 63·8 per cent. burning coke.

There are two kinds of *open fire with back boiler*: one with a small block back boiler capable of heating a 30-gal. storage cylinder, and the other with a large back boiler capable of heating, in addition, 35 sq. ft. of radiator surface (or 70 sq. ft. if there is no water heating). The former are required to have a heat output of not less than 7,500 Btu/hr. and an overall appliance efficiency of 45 per cent. and the latter must give a test bench output of 10,000 Btu/hr.

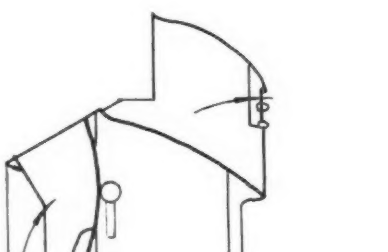


Fig. 1. Stand-in convector open fire.

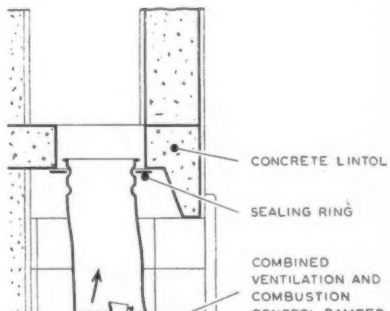


Fig. 3. Down-draught open fire.

TABLE 2 PERFORMANCE OF FOUR TYPICAL SMALL BACK BOILERS

	A	B	C	D
1. Conditions to give	Maximum hot water	Maximum room heating	Minimum output	Average domestic usage in London area
2. Position of dampers	Flue damper open. Air control full open	Flue damper shut. Air control full open	All dampers shut	Various
3. Refuelling period	Every hour; rake lightly every 2 hours	Every hour; rake lightly every 2 hours	Every 4 to 5 hours	Various
4. Combustion rate, lb./h.	3¼	2¾	0.9	1.65 (150 lb./week of 90 hours)
5. Distribution of average heat output—				
(a) Radiation, per cent	26	33	18	24
Btu./h.	11,000	11,600	2,100	5,100
(b) Hot water, per cent.	20	15	19	17
Btu./h.	3,600	5,100	2,200	3,700
(c) Heat from lagged storage tank and flow and return pipes, per cent	3	3	6	3
(d) Overall efficiency total, per cent	49	51	43	44
6. Time taken to reach maximum output starting cold; gas ignition; no blower plate, minutes	60	60	—	—

TABLE 3. LARGE BACK-BOILER. PRACTICAL USAGE TEST—APPLIANCE CONNECTED TO A 30-GALLON LAGGED STORAGE CYLINDER

Combustion rate (coke)	1·83 lb./h.
Heat input	23,400 Btu./h.
Radiation from fire	5,280 Btu./h. (22·5%)
Radiator	2,190 Btu./h. (9·4%)
Hot water at tap in 12-hour test period	36·3 gallons at 134° F. (17·7%)
Average radiator temp.	113° F.
Average room temp.	61° F.

TABLE 4. PERFORMANCE OF OPENABLE HEATING STOVES. FUEL: GAS COKE, SIZE 1 IN. TO 2 IN.

Test No.	1	2	3	4
Test condition	Doors open	Doors closed	Doors closed	Doors closed
Recharging period, hours	1½	1½	3	6
Combustion rate, lb./h.	2·78	2·8	2·38	1·32
Radiation output, Btu./h.	5,590	5,025	4,620	2,220
per cent.	15·7	14·0	15·1	13·0
Convection output, Btu./h.	9,510	20,420	16,500	9,460
per cent.	26·7	56·9	53·9	55·9
Total space heating, per cent.	42·4	70·9	69·0	68·9

and an efficiency of 50 per cent. Typical running data for the small boiler type are given in Table 2 and for the large boiler type in Table 3.

A point about the large boiler type is that the appliance works very well provided the householder realizes its limitations. Thus it is important that a valve should be provided in the radiator return pipe near the boiler so that the householder can turn off the radiators when he wants a rapid recovery rate of domestic hot water. In local authority housing this type averages 1¼ to 1½ cwt. of coke per week for 30 winter weeks.

Heating Stoves

The advantages of stoves over even the most efficient open fires are that they burn for longer periods without attention with a more constant heat output, they are more flexible, they burn all night at low rates of combustion and need only low rates of air change. Lastly they are more efficient in their use of fuel. Against this it is important to realize that they give a *different kind of service.* The open fire is essentially an intermittent appliance—you get warmth quickly from it. The stove is a continuous burning appliance and takes longer to heat up. Again, the open fire heats mainly by radiation and therefore can provide comfort conditions with an air temperature of 60° F.; but the stove heats mainly by convection and produces equivalent comfort conditions only with an air temperature of 70° F. Also the temperature gradient produced by a stove can be 70 per cent. greater than with an open fire.

There are two main types of stove available: the openable, manufactured for English usage, and the closed or continental type. The greater efficiency of the closed as against the open type can be gauged from Table 4 which compares performance data for an openable stove with tight fitting doors with doors open and doors closed (using incidentally the continental test method).

Another advantage of the closed type is that it permits top filling, which increases fuel capacity and makes it possible to have a hopper feed.

It is exceedingly important with stoves of these types that an accurate assessment be made between space heating and water heating requirements. This is made difficult by the fact that not enough data concerning the performance of these stoves is published by manufacturers. In Holland (where, however, stoves *do not* heat water as well) they have a method of rating which all can understand: the rating (obtained by dividing the heat output in Btu by 6) is expressed by the volume of the room which can be heated satisfactorily. The combustion rate of the fuel at the rated output must not exceed 8·0 lb. per sq. ft. grate area per hour and the continental efficiency must not be less than 80 per cent.

Heating stoves are available both free-standing and inset. When free-standing they usually have a back flue outlet which is lower than the height of the fireplace so that the stove can replace an open fire without undue bother. When this is done the fireplace opening is sealed with a closure plate on which it is advisable to have an adjustable opening about 12 sq. in. near the hearth. This gives some ventilation and gives added control of the combustion rate.

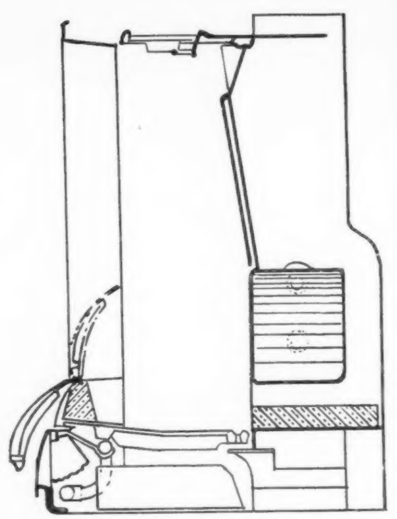


Fig. 4. Open fire with small back boiler.

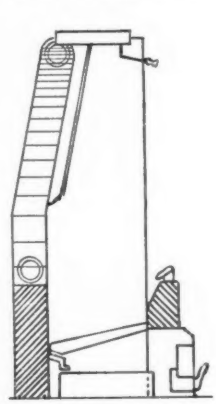


Fig. 5. Open fire with large back boiler.

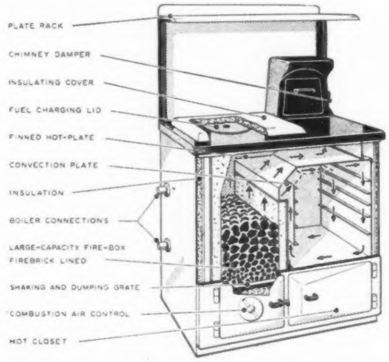


Fig. 6. Lightly insulated cooker.

The latter is all the more necessary as few stoves are provided with chimney dampers and banking is difficult with a good chimney. The fire regulations require that the hearth should extend at least 12 in. beyond the front of the appliance: this would mean extending the hearth by about 12 in., which in fact is seldom done.

Cookers

There are two types of free-standing cooker; the *heat storage cooker* and the *insulated cooker.* The heat storage type differs from all others in that it is designed to operate at a combustion rate controlled by thermo-

stat: the "buffer" effect of high-heat-capacity heavy castings maintaining a substantially constant oven and hotplate temperature. The combustion rate is sufficiently constant to enable the makers to guarantee fuel consumption.

With the insulated-type cooker combustion rates vary very considerably, as can be seen in Table 5 (which applies also to *combination grates*) and it is this which makes this type wasteful of heat at certain times, *e.g.*, in the summer when the cooker is only wanted for water heating and occasional baking. For this reason it is concluded that it is only suitable for the large kitchen or the kitchen/living room in areas where some space heating is required most days of the year.

TABLE 5.

Duty	*Coke combustion rate per hour. Average*	*Hot water, Btu./h. approximate limits*
Oven (roasting temperatures)	2½	6,000–11,000
Hotplate (simmering and boiling)	1¼	4,000–5,500
Overnight banking ..	¾	1,500–4,500

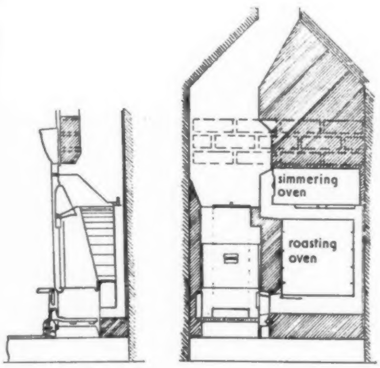


Fig. 7. Combination grate.

The *combination grate* differs from the insulated cooker in that the flues inside the appliance have to be cleaned, the firebox is smaller, and controls are provided to vary heat to the boiler and to the oven.

Conclusion

The first point in conclusion is that the design of the open fire cannot be greatly improved unless it is released from the limiting dimensions of the traditional fireplace. It is for this reason that the competition for the design of free-standing open fires, organized in connection with the Conference, was so welcome. The second point concerns the chimney: the traditional 64 in. cross section is too big and the traditional pargetting is unsuited to modern appliances. Experience shows that 7 in. by 5 in. is about right for dimensions and that *ciment fondu* is the best material for the liner.

The next point relates to the vital question of the ownership of appliances in rented houses. It is essential that appliances be owned by the tenant, since he alone has the incentive to save fuel. This requires that we should evolve an easy system for connecting appliances to the flue. One way of doing this would be to use a standard flue with a slot in the base to accommodate flue spigots of varying height from the hearth and thus make replacement easy.

The next point concerns the rating of appliances. In this country domestic boilers are the only solid-fuel appliances to be so rated. The ratings of open fires do not vary greatly between one make and another, and the only decision which has to be taken is whether to fit a 14-, 16- or 18-in. fire (maximum room sizes for which, taken from the Gas Council Handbook, are given in Table 6), but the ratings of apparently similar free-standing appliances vary widely and it is important that some equitable convention should be established for rating them. This must make clear whether they are designed for intermittent or continuous burning and whether they heat mainly by radiation or by convection.

At the moment the only way an architect can tell whether a stove is likely to be large enough for the room to be heated is to disregard all ratings and check the fuel capacity, for this will be approximately proportional to the heat output. Table 7 (which is likewise taken from the Gas Council's Handbook) gives the maximum room sizes which the different fuel capacities will heat. It must be remembered, however, that none of the convected warm air may be subtracted to heat another room.

Lastly there is a strong case for abolishing the dual-purpose appliance and for separating winter space- and water-heating loads as they do on the Continent.

TABLE 6.

16 in. fire		18 in. fire	
With chimney ventilation control	Without chimney ventilation control	With chimney ventilation control	Without chimney ventilation control
2,000	1,750	2,250	2,000
16 in. fire with boiler		**18 in. fire with boiler**	
With chimney ventilation control	Without chimney ventilation control	With chimney ventilation control	Without chimney ventilation control
1,750	1,500	2,000	1,750
Convector fire without boiler		**Convector fire with boiler**	
Convection to same room	Convection to other room	Convection to same room	Convection to other room
2,250	1,750	2,000	1,500

TABLE 7

Maximum room size, cu. ft.	Convection to same room	
	With back-boiler. Fuel capacity, cu. ft.	Without back-boiler. Fuel capacity, cu. ft.
1,500	0·51	0·35
1,900	0·57	0·40
2,100	0·63	0·45
2,400	0·69	0·50
2,700	—	0·55
3,000	—	0·60

Appliances and systems (continued)

The Use of the List of Recommended Domestic Solid Fuel Appliances

by A. G. Ludgater, A M I H V E, of the Solid Smokeless Fuels Federation, and W. C. Moss, A M I H V E, M Inst F, of the Coal Utilisation Council

The list of recommended appliances only lists the appliances of each type which have been found "efficient": it does not tell you when to use which. The purpose of this paper (which was written by technical advisers of the two organisations which publish the list) sets out to do exactly this. The authors take each heating job in turn and list the type of appliance which would do it best. In the course of their paper they suggest that the time may have come to raise the standard of efficiency and to strike the inset open fire off the list.

The history of lists of approved appliances is already quite long: the London and Counties Coke Association issued their first list back in 1938. The first Ministerial list was that prepared by the Ministry of Fuel and Power and issued by the then Ministry of Health in 1947.

The purpose of this list (and the main purpose of all subsequent official lists) was to give guidance to Local Authorities on what appliances to use in low cost housing, which was later to be extended to all applicants for improvement grants. For this reason the first list contained only appliances which were judged both efficient and cheap. Other lists were prepared by the CUC and the SSFF and in 1955 the two latter produced a joint list which superseded all previous lists. This joint list (List No. 11) includes all appliances which have been found efficient, the cheaper ones judged

suitable for low cost housing being distinguished by an asterisk. It gives general guidance on how to choose an appliance for a given job, lists the appliances by the classes to which they belong, quotes the fuels for use for each and adds occasional notes on the different features of individual appliances. It does not show prices.

It is interesting to notice the progressive increase in the number of appliances, which has grown from 26 in 1947 to 575 in 1956. This reflects not a lowering of the standard but an increase in the interest of manufacturers. Nevertheless, the list is not so critical as it might be. Though appliances are retested (and some have been removed) the time may well have come when the standards of minimum performance could be raised. Further, the list as it stands does not attempt to discriminate between one *type* of appliance and another: it only discriminates between the better and the worse appliances of each type. The time may come when it is no longer considered desirable to include the inherently inefficient inset open fire in the same list as convector fires and stoves.

Though the list gives *general* advice on how to select a stove, it does not give *specific* advice since it is, after all, only a list and it has been thought best to keep notes to a minimum. The chief purpose of this paper is to give some of the specific advice which is missing.

The test of efficiency is exceedingly difficult to apply to British appliances owing to the prevalence of the multi-duty type. There is no doubt that an appliance which has one function to perform will do so more efficiently than one that has two or more: but so long as the multi-purpose appliance can serve two or more uses *well enough to satisfy the user*, and use less fuel at the same time, there will always be a demand for it. The tragedy of appliance choosing up to now has been the tendency (particularly with Local Authorities) to make first cost the only criterion, with little regard either to the money the householder can spend on fuel or to the service he should get from it.

In the Introductory Notes to the list the types of appliance on the market are given in an ascending order of efficiency. They run as follows:

TABLE 1.

1. Open fires (Sections A(i), B(i).
2. Open fires with convection (Sections A(ii), A(iii), B(ii), B(iii).
   Open fires with back-boilers (Section C(i)).
3. Openable stoves (Sections E(i), E(ii)).
   Open fires with back-boilers and with convection (Sections C(ii), C(iii)).
4. Open-fire independent boilers (part of Section J(i)).
   Openable stoves with back-boilers (Sections F(i), F(ii)).
5. Closed stoves (Section E(iii)).
   Closed independent boilers (part of Section J(i), Sections J(ii), J(iii)).
6. Gravity-feed boilers (Section J(iv)).

This list excludes appliances which undertake cooking, since the efficiency criterion for such would be quite different, and excludes also whole house warming systems—though these would fall into groups 5 or 6. In attempting, in this paper, to be more specific than this, it is necessary to use some concept such as "highest feasible efficiency" which includes not only test bed efficiency but less easily definable criteria such as first cost in relation to the purchaser's income, his preferences, the desirability or otherwise of combining two heating functions in one, and the supply of fuel.

Small Room Warming

By a small room is meant not more than 1,750 cu. ft. capacity if well insulated or 1,400-1,500 cu. ft. if with normal or greater than normal heat losses. For these the possible choices (in reverse order of test bed efficiency) are:

1. inset open fire 16 in. size
2. convector open fire
3. free-standing convector open fire
4. openable stove
5. closed stove
6. radiator(s) from boiler elsewhere.

Of these, nos. 4-6, the stoves and the radiator can provide the heating at the lowest running cost if the user can be persuaded to pay for their installation. If he demands to see the fire, then the openable stove is the proper choice. If he demands to see more of the fire than this permits, then the free-standing convector (3) is the choice or the convector (2). The inset fire is the last resort and if chosen must have a restrictable throat.

It is important for people to realise that quite small stoves (4 and 5) can be bought, that they can show great savings because they can be burnt slowly in mild weather and that a mode of heating which uses some form of convection is essential to produce comfort conditions.

Large Room Warming

A large room is any room larger than 2,000 cu. ft. capacity, no matter how well insulated: that is, any room too large to be heated adequately by a simple open fire. The possible methods for heating (once more in reverse order) are:

1. inset convector open fire (if room not larger than 2,250 cu. ft.)
2. certain free-standing convector open fires
3. open fire plus one or more radiators (heated either by boiler behind fire or independent boiler)
4. openable stove
5. closed stove
6. hot water radiators

An important snag to be remembered in respect of (4) and (5) is that the manufacturer's listed rating is always about 25 per cent. too high and that until it has been agreed to use a more realistic convention, due allowance must be made. The alternative of supplementing an open fire with radiators (3) is gaining in popularity. When these are heated by a back boiler the overall efficiency (using coke) is about 55 per cent.

Two-room Warming with one Appliance

This is a heating expedient which was very popular immediately after World War II when many houses were built with only one flue and were supplied with inset openable stoves. The important thing to realise is that this expedient merely *apportions* the output; it does not increase it. The rules are, first, don't duct the warm air away if the remaining radiation is not enough to heat the room where the appliance is installed; second, don't attempt to heat more than one other room; and, third, fit closable outlet grilles in both rooms so that all the heat can be directed to either at will.

The possible methods, in ascending order, are:

1. convector open fire
2. open fire or inset stove with boiler heating a radiator in the second room.
3. as 2 but with large back boiler heating radiators in both rooms and domestic hot water also.
4. radiators from a central heating system.

To these may be added (if the room in which the appliance is set is *very* small—1,000 cu. ft. or less) an inset openable stove with convection ducted to a second room.

Partial Central Heating

This may mean one of two things: either the full heating of two or three rooms only, or the background heating of the whole house to a temperature of 50° F. or 55° F.

The possible methods are:

1. open fire with large back boiler in living room heating a limited number of radiators in other rooms.
2. independent boiler of "pot" type in kitchen, preferably with thermostatic control and radiators.*
3. sectional boiler and radiators.*

Of these, alternative 2 may not provide enough heating if the house is a large one; and alternative 1 assumes that the fire will be alight all the time.

Full Central Heating

The possible methods (*not* listed in any significant order) are:

1. hot water heated by sectional boiler.
2. hot water heated by gravity feed boiler.
3. warm air using "Radiation" system.
4. warm air using "Weatherfoil" system.

The smallest sectional boiler 1 is of just over 5 sq. ft. boiler heating surface, which is equivalent to a rated output of 23,000 Btu/hr. Thermostatic control is strongly recommended. A gravity feed boiler is very efficient and needs little attention, but is expensive in first cost and may give rise to fuel supply difficulties. Most use small graded anthracite which can only be obtained under the "small anthracite scheme," but a few use small graded coke. The main difference between the Radiation and Weatherfoil hot air systems is that the former delivers the air through ducts and therefore is mainly suitable for building into new houses, while the latter discharges from one point and therefore requires some measure of open planning. An open fire in the living room can be used with either, but it is not desirable, and it would in any case be essential to fit a flue damper to avoid loss when the fire was not lit.

* or heating panels.

Hot Water Combined with Room Warming

The incorporation of a boiler in a room-warming appliance increases its efficiency, but consideration must always be given to summer use. The alternatives are either to install an immersion heater or to employ some form of closure plate which enables all the room-warming heat to be diverted to water heating. The possible methods are:

1. open fire with small back boiler.
2. open fire with large back boiler.
3. convector open fire with boiler.
4. free-standing open fire with back boiler.
5. openable stove with back boiler.

The radiant output of an open fire with a small back boiler is less than one without and it should not be used in a room of more than 1,500 cu. ft. if well insulated or 1,300 if not. The same limitation applies when there is a large back boiler unless part of the boiler output is used to heat a radiator in the same room. This version (if there are no radiators) can be used with a 40- or 50-gal. cylinder though all the others can only be used with one of 30 gals.

Cooking (usually combined with hot water)

The choice of cooking and water heating appliances are largely conditioned by the relationship of the kitchen to the living room. With a working kitchen and separate living room there are two main alternatives:

1. free-standing insulated cooker
2. heat storage cooker.

The second of these two is likely to be the more economical in running but will be more expensive in first cost. In neither case is the boiler large enough to heat a cylinder of greater capacity than 30 gals. If much space heating is wanted in the kitchen the free-standing insulated cooker should be chosen with an open front, though this will use more fuel than the closed front version. The kitchen living room is more popular in the north than in the south since, in the north, living room warming in the summer is considered an advantage. The most popular choice for this is the side-oven combination grate. This will heat a 30-gal. cylinder (if it is insulated) provided the room is not larger than about 1,300 cu. ft.

For two-room flats and old people's houses the oven-over-fire type combination grate can often serve. This is more limited as regards both cooking and water heating when compared with the side oven type.

Appliances for water heating only are similar to those discussed for central heating. An important point to notice in the list is the two parallel columns giving "Rated output at 6,000 Btu/hr./sq. ft.," and "Catalogue rated output," the latter giving figures nearly twice those in the former. The "catalogue rating" is an unrealistic figure based on a two-hour refuelling interval which no householder is likely to work to in practice. It is therefore always advisable to use the lower "rated output" figure.* Another general point is that it is better to use a thermostatically controlled, as against a hand controlled, boiler if the user can afford it.

* The authors of the next paper (see below) suggest that even this figure, based on 4-hourly refuelling, is too high and that what the houseowner really wants to know is what his boiler will do when refuelled twice daily.

Appliances and systems (continued)

Domestic Hot Water and Central Heating Boilers Fired by Solid Fuel

by C. Fishlock, M Inst Gas E, M Inst F, and A. J. Forder, A M I H V E, M R S H Technical Advisers to the Coke Department of the Gas Council

The authors describe each class of domestic boiler, giving the ratings, and price range of each and the expected fuel consumption with the boiler connected into appropriate systems. They give special attention to automatic firing, describing not only the types of boiler in which this is provided by the makers but mechanical firing equipment which can be used to convert existing boilers from manual to automatic firing. In conclusion they lament the present trade practice of rating boilers according to three different conventions and ask that all should be rated under controlled test conditions and in a manner which will take refuelling cycles into account.

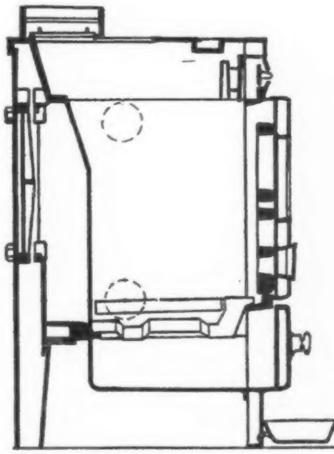


Fig. 1. Open-fire boiler.

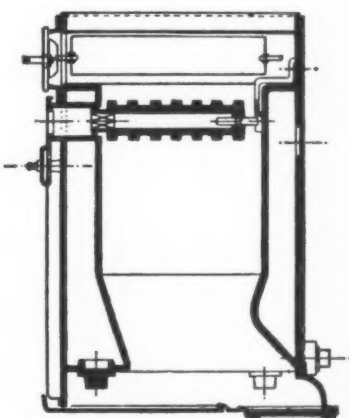


Fig. 2. Closed boiler.

The first factor a heating engineer has to take into account in choosing a boiler is the published rating. Unfortunately this does not tell him all he wants to know as he has to apply an additional factor termed the "boiler margin" which takes into account such matters as the refuelling cycle and intermittency conditions, which he must work out for himself. The first class of boiler for which a rating figure was assessed was the large sectional heating boiler which was given (in 1911) an arbitrary value of 4,400 Btu/hr. per sq. ft. of heating surface, a figure which was based on a 6-hourly refuelling cycle and is still recognized.

A 6,000 Btu figure and a four-hourly refuelling cycle is used in BS. 758:1955, for small domestic hot-water supply boilers with manual control up to 5 sq. ft. heating surface; and the same criterion is used for the thermostatically controlled versions covered by the Gas Council (Coke Department) Approval scheme. Boilers of designs other than sectional and pot types of which the heating surface is complex and not readily measurable are rated under con-

trolled test conditions according to their maximum heat release.

For the purposes of this article we must follow current trade practice, and in quoting ratings use the three different conventions for three different types of boiler: 6,000 Btu/hr./sq. ft. of heating surface for *Domestic hot-water supply boilers,* 4,400 Btu/hr./sq. ft. of heating surface for *sectional heating boilers* and tested outputs for *tubular, gravity feed* and *pre-burner* units. One general point to be noticed is that small boilers (*i.e.* below 150,000 Btu/hr.) intended for use in a kitchen will tend to be more expensive in first cost per 1,000 Btu simply because they must be enclosed in an insulated, easy-to-clean shell. Boilers above this rating are designed for siting in a boiler house where much of the insulation and finishing will be applied as part of the installation contract.

Small Domestic Hot-water Supply Boilers

The manually controlled boilers of this class are covered by BS. 758:1955. Their heating surface is wholly primary, *i.e.* exposed to direct radiation from the fire bed, and falls within the 2—5 sq. ft. range giving ratings of 12,000—30,000 Btu/hr. Intended for installation in the kitchen and designed primarily for hot water supply, they give out a considerable amount of incidental space heating. There are two design types: one with an open fire type boiler for use with pressures up to 90 ft. head of water, has front fire bars and a door which can be opened for added space heating (see Fig. 1); and the closed type in which the boiler shell encloses the fire on all sides, giving greater mechanical strength and a permissible working pressure of 120 ft. head of water (Fig. 2). When used in a 4-hour refuelling cycle the fuel-to-water efficiency of these boilers is not less than 50 per cent. for the open fire type and 60 per cent. for the closed type. At the same time it must be pointed out that the service the householder gets depends to a very great extent on skill in handling. For this reason there is a strong case for using thermostatically controlled models.

The 12,000 Btu/hr. size costs from £13 10s. if manually operated, from £25 if thermostatically controlled and serves a 30 gal. storage tank and towel rail using 2½ tons of fuel per annum (50 weeks).

The 30,000 Btu/hr. size costs £40 (whether manually or thermostatically controlled) and serves a 40 gal. storage tank with 80 sq. ft. of radiator surface including pipework using 4½ tons per annum (50 weeks for water, 30 weeks for space heating).

Small Sectional Heating Boilers

Though there are sectional hot-water supply boilers on the market these are designed to meet high bulk water demand and do not therefore come into the ordinary domestic field. Heating boilers of this type can be encased in a way to make them acceptable in a kitchen but are more usually sited in a basement or boiler house and therefore are usually sold without outer casing and must be insulated on installation. Though intended for heating, they are increasingly used to provide hot water also, and as they have additional secondary surfaces they are run at higher efficiencies than the pot type (see Fig. 3). When working on 5-6-hr. refuelling cycles efficiencies are found to be 65-70 per cent. Thermostatic control shows savings over inefficient manual control and balanced flue dampers can be obtained to ensure a steady control of water temperature with all flue conditions.

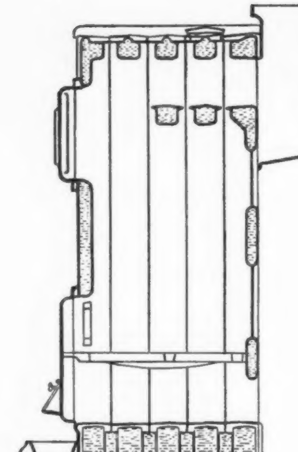


Fig. 3. Sectional heating boiler.

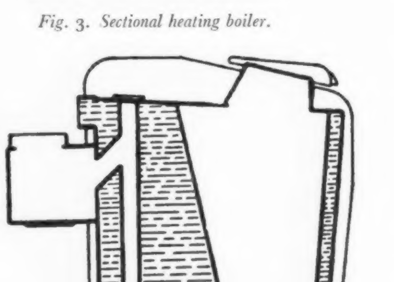


Fig. 4. Gravity feed boiler.

The price range for manual control is from £27 for 30,000 Btu/hr. to £85 for 130,000 Btu/hr. rating, and for thermostatic control from £40 to £100.

As a guide to fuel consumption a 40,000-Btu/hr. output serving a 40-gal. storage cylinder and 100 sq. ft. of radiator surface including pipework uses 5 tons per year (50 weeks hot water, 30 weeks heating): while a 150,000-Btu/hr. output serving a 60-gal. storage cylinder and 600 sq. ft. of radiator surface including pipework uses 16 tons per annum operating for like periods.

Small Gravity-feed Boilers

These provide automatic water temperature control and differ from hand-fired sectional boilers in giving automatic fuel feed to the fire: further they are designed to operate for 8-12 hours without attention at the rated output and have a higher efficiency of 75-80 per cent. The casing of these boilers is designed for standing in the kitchen, but the larger sizes may have to be put in a basement or boiler house. They are made of steel and have a safe working pressure of up to 150 ft. head of water (see Fig. 4).

Fuel consumptions (assuming 50 weeks hot water and 30 weeks heating) are as follows: The 50,000-Btu/hr. version serving a 50-gal. storage tank and 175 sq. ft. radiator surface including pipework uses 6 tons per annum: the 150,000-Btu/hr. version serving a 75-gal. storage tank and 750-sq. ft. radiator surface including pipework uses 14 tons per annum.

Automatic Forced-draught Boilers

It is considered that hand-fired boilers for blocks of flats up to 1,000,000 Btu/hr. can be operated by a part-time stoker, but that

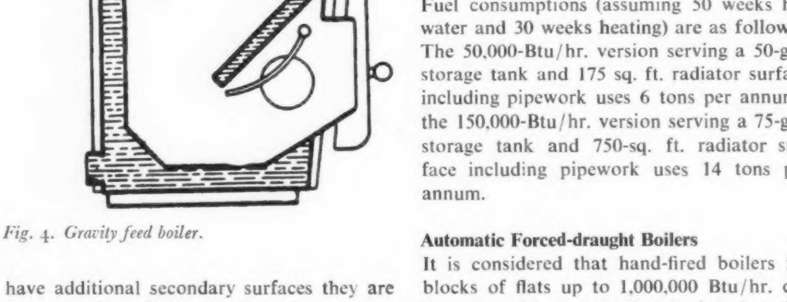


Fig. 5. Underfeed stoker.

above this rating a full-time stoker is required. For this reason great interest attaches to the post-war development of various types of large boiler with fully automatic operation. One of these is the automatic forced-draught boiler, the layout and cross-section of which can be seen in Figs. 6 and 7. One elevator charges the boiler hopper and another removes ash and clinker. Boilers of this type need only a brief inspection once a week and cleaning of the boiler tubes and inspection of the controls once every three months. They are made with outputs ranging from 250,000 Btu/hr. to 2,000,000 Btu/hr. As an example of costs, an installation rated at 1,000,000 Btu/hr. with conveyor-belt equipment would be approximately £1,590 and would use about 120 tons of fuel during a 30-week heating season.

Mechanical Firing Equipment

It is worth noticing that most types of central-heating boilers rated from 400,000-2,500,000 Btu/hr. can be fired automatically by the use of newly-developed gravity feed stokers. These lower operating costs and can raise the average operating efficiency by as much as 15 per cent. There are two methods of achieving this result: the *underfeed stoker* and the *pre-burner unit.* The underfeed stoker carries fuel into the combustion chamber by a worm feed (Fig. 5). The pre-burner unit is analogous to an oil-fired burner in that a complete and separate burner unit is placed alongside the existing boiler and discharges into it. The pre-burner (Fig. 8) is fuelled by a hopper which is placed directly over the burner, and requires about 1½ hr. attention per day. The cost of a pre-burner is about £300 for the 400,000-Btu/hr. rating, £500 for 1,500,000 rating, and it is reckoned that its use should result in a 20 per cent. fuel saving.

Conclusion

One particular need is that all boilers should be rated under controlled test conditions and in a manner which will take refuelling and de-ashing cycles into account. What, for instance, the user of a domestic boiler wants to know is not what his boiler is capable of when run at full output or when refuelled at 4-hr. intervals, but what it can do with the twice-daily refuelling which he intends to give it. Another need is for greater flexibility in boilers: other factors being equal, there is an advantage in running full central heating and hot-water supply off one boiler, but the boiler must operate equally well on summer domestic hot-water load as on full winter load. One last point concerns the flue. Automatic boilers running at an efficiency of round about 80 per cent. cannot improve significantly on this if they discharge into a conventional flue, since gases must enter this flue at a certain minimum temperature to avoid condensation troubles. For higher efficiencies to be obtained it would be necessary to use some other means of extracting and disposing of waste gases.

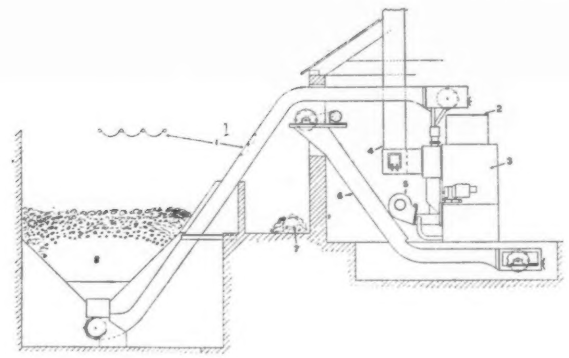


Fig. 6. Layout of automatic feed and ash-disposal system.

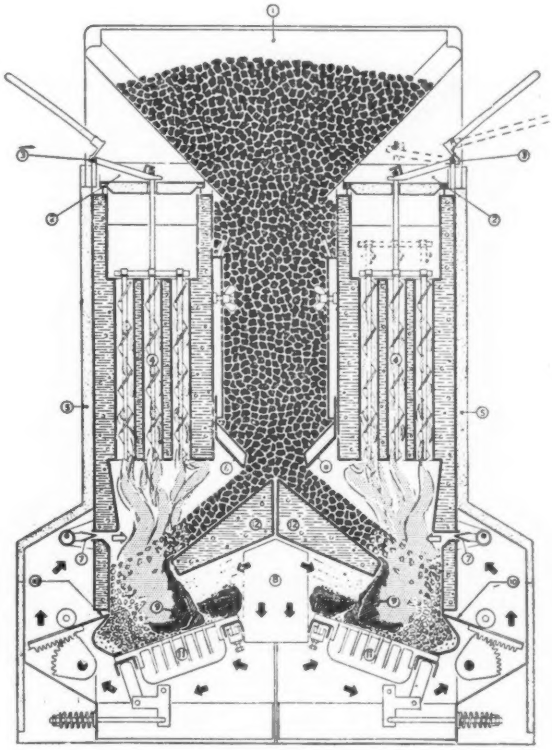


Fig. 7. Section through large automatic boiler.

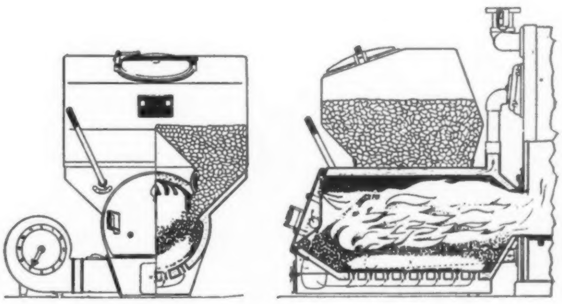


Fig. 8. Section through pre-burner unit.

Appliances and systems (continued)

Present Position and Future Development of Domestic Heating Appliances Fired by Gas

by L. W. Andrew, Manager, Watson House, and D. R. Wills, a member of the staff of Watson House

The authors begin by pointing out two important defects in the criteria of house and room heating efficiency as practised by BRS: namely that air temperature and not " equivalent " temperature is made the basis of comparison, and that all heat put into the house is regarded as useful heat—which it isn't. They point out that with a climate like ours what matters is not how to produce certain steady state conditions of air temperature but how to produce the right kind of heat in the right place when it is wanted. They then discuss the technical performance of radiant and convector flued fires, balanced flue convector heaters, and fan circulated warm air heaters; and conclude with a summary of the performance and uses of gas water heaters.

At the present time only 10 per cent of gas used is applied to space heating: a recent survey by L. C. Wilkins showed that of households with incomes up to £20 per week 96 per cent. used an open coal fire to heat the living room and only 2 per cent. used gas. There are a number of factors, however, which may alter the pattern of space heating, among them being the increased price of solid fuel, the greater number of multi-storey dwellings and the fact that in an increasing proportion of families both man and wife go out to work and leave the home unoccupied during most of the day.

In making an assessment of space heating appliances it must be noticed first that " test bench efficiency " though useful in comparing appliances of similar type is of no use in comparing appliances of different type; second that the concept of " house heating efficiency " put forward by Dr. Weston, though useful in comparing systems in a broad way, has two defects, namely that it uses air temperature only as a basis for comparing levels and that it regards all heat put into the house as " useful heat," which it rarely is; third, that much the same shortcoming applies to the concept " room heating efficiency " and its corollary " useful therms." " Useful therms " is used to express heat which enters the room in some form or other and is not lost by excess ventilation. It does not take into account such factors as temperature gradients and distribution both of which have a considerable bearing on comfort. It would be better, therefore, if this heat was described as " room heating input efficiency " and that its use were confined to comparing appliances of the same general type.

In a climate like ours where intermittent, periodic heating is the rule, and continuous heating is the exception, factors other than efficiency, such as flexibility and controllability, are of real significance. For instance the methods of calculation for the desirable size of an appliance given in the Codes of Practice (whether solid fuel, gas or electricity) are based on steady state conditions of air temperature: they do not take into account the difference between air and " equivalent " temperature, nor do they consider the need for rapid heating up. It is probable that appliances of higher rating should be used than those suggested by these steady state heat loss calculations.

Flued Gas Fires

Surveying the field of gas space heating appliances and beginning with flued gas fires it is worth making the comment that comfort conditions cannot be separated from ventilation and that the gas flue is designed not only to carry off flue gases but to ensure good ventilation. Recent tests by Bennett and Reichert on one 8-storey block of flats in which 6 in. dia. gas flues had been installed showed that ventilation rates varied from 1,500 cu. ft./hr. to 3,500 cu. ft./hr. with an average midway between the two. Though these are not excessive, they are enough to keep rooms fresh.

Turning to comfort distribution, Dr. Hartley in his 1953 Melchett lecture pointed out the importance of maintaining comfort conditions below a level of 4-5 ft. from the floor. The effectiveness of a gas fire in this respect can be judged from Table 1 which gives a comparison of the vertical distribution of radiant heat from a gas and a coke fire (note that the gas fire emits more to the floor than to the ceiling).

There are three types of conventional flued gas fires: the *hearth type radiant fire*, the *panel fire* and the *portable hearth fire*. The efficiencies and ratings of these and of the other gas space heating we are considering can be seen in Table 2.

In comparing these efficiencies it is important to bear in mind that the method of evaluating them takes into account neither the 2-3 per cent. extra which is given by convection from the outer casing, nor the heat (which may account for a much larger figure) which is given off into the room by the heated flue. Nevertheless, a conventional radiant fire can never achieve the percentage efficiency of a convector/radiant fire. Its chief virtue arises from the fact that it attains about 50 per cent. of its

TABLE 1
RADIANT HEAT DISTRIBUTION

To:	Proportion of total heat emitted	
	Gas fire	Coke fire
Floor ..	0·40	0·20
Ceiling ..	0·15	0·38
Wall opposite fire ..	0·22	0·14
L.H. wall ..	0·12	0·15
R.H. wall ..	0·11	0·13

TABLE 2. COMPARATIVE EFFICIENCIES OF GAS APPLIANCES

Appliance	*Range of heat input, Btu./h.*	*Test-bench efficiency, %*	*Heat service application*
Fixed hearth flued fire. Radiant only	14,000—36,000	40* to 45	Short-period heating of dining rooms and bedrooms
Fixed-hearth flued convector fire	16,000—18,000	50* to 56	Longer-period heating for living room, main bedroom or dining room
Portable hearth fire, mainly radiant	10,000—12,500	40* to 45	Short-period and mild-weather heating. Living rooms and dining rooms
Flued convector heaters. Mainly convection	22,500	70 to 75	Longer-period heating
Balanced-flue heaters. Mainly convection	7,500—12,500 (Refers only to appliances made in this country)	70 to 75	Longer-period heating of rooms without flues or background heating
Air heater with fan-assisted warm-air circulation	18,000—22,500	70 to 75	Longer-period heating of one or two rooms. General background heating
Flueless portable appliances	3,000—6,000	90	Mild-weather use, and for short-period heating
Flueless fixed heaters:			
(*a*) Wall fixing	3,000	90	Background heating.
(*b*) Floor fixing	6,000—10,000	90	Background heating of large halls or large rooms

***Room-heating efficiency will be several units higher. The Ridley Report gives values, based on the Abbots Langley results, about 5 units of efficiency higher than the test-bench figures.**

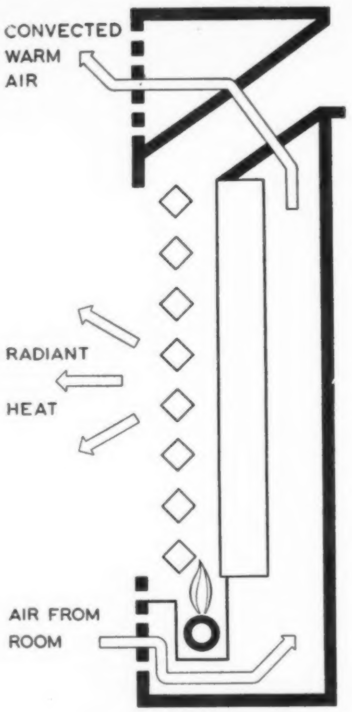


Fig. 1. Diagram showing basic principles of convector fire.

full output in about 3 minutes and 90 per cent. in 17 or 18 minutes. This virtue could perhaps even be improved upon by up-rating the fire and thus giving it greater pre-heating power, with a clearly marked "turn-down" position for normal running.

The evolution of the *convector fire* reflects the growing interest in gas for longer as against short period use. Air passes round the back of the fire and convected heat is obtained either from the back brick (as in Fig. 1) or from the flue products after they have left the radiating surface. Convector fires provide from 20 to 30 per cent. more heat to the room than a conventional radiant fire. They would do even better than this if they could take all their heat from the escaping gases instead of from the back brick, but unfortunately they are victims to the traditional hearth and the restriction in the height of the flue spigot which it imposes. Convector/radiant fires have thus been designed too closely on the lines of the conventional radiant type. Further, the need to provide the heating surface at the back makes the fire bulky and expensive. Failing great height, efficiencies of 70 per cent. could probably be obtained either by reducing the size of the radiating component or by incorporating a small fan, though, since the convector fire is designed for long period use, it may already reach this efficiency due to the considerable heat gain to the chimney up to the first floor ceiling. Like the radiant version, the convector warms a room quickly since its radiant component develops its heating output at the same rate: the convection output, however, only reaches 50 per cent. in 9-10 minutes and 90 per cent. in 40-50 minutes. All factors considered it is probable that the convector type provides a better thermal environment at lower cost than the radiant type and certainly offers better promise of still higher efficiencies.

Balanced Flue Convector Heaters

In balanced flue heaters (Fig. 2) the heater is sealed from the room: ducts convey air to the heater and combustion products to the outside air, the air inlet and flue outlet being so disposed that wind pressure effects are substantially balanced. This system, therefore, dispenses with the conventional flue. In performance this type of heater is best compared with hot water radiators: though as each heater is individually operated it is more flexible in use than a heating system from a central source. However, balanced flue convector heaters are not suitable for really short period heating. They develop a high efficiency (70-75 per cent.) but are still rather expensive: nevertheless they might well prove a useful heat source for multi-storey buildings as they require no flue and give the tenant full control.

Convector Heaters with Fan-circulated Warm Air

"Whole house" heating produces higher average house temperatures and higher fuel consumptions than conventional heating. Of particular interest in this connection is a smaller independent unit which offers a flexible form of heating to something less than "whole house" standard. This (see Fig. 3) has a bench efficiency of 75 per cent. and an input rating of 18,000-22,500 Btu/hr. Placed centrally on the ground floor of a house it forces warm air downwards through grilles giving into three different rooms and can thus be adjusted to give full heating into one (or, if they are not too big, into two) or background heating to all of them.

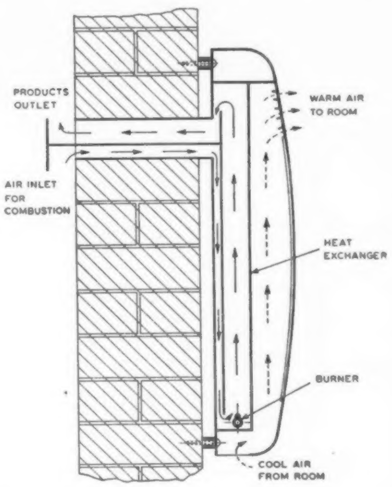


Fig. 2. The principle of balanced-flue heating.

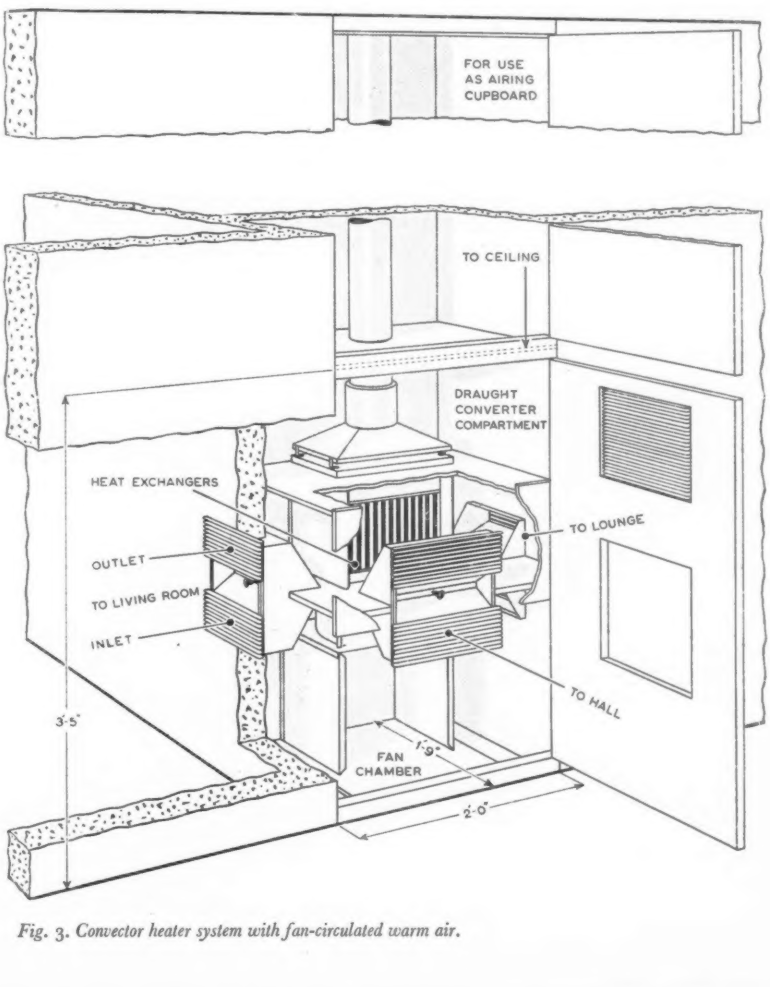


Fig. 3. Convector heater system with fan-circulated warm air.

Hot Water Appliances

Until recently hot water service by gas was mainly at individual points or as an auxiliary to solid fuel in the summer when space heating was not required; but it has now been established that a full all-the-year-round hot water service can be provided by gas at reasonable cost. The Egerton Report called for the provision of a maximum of 250 gallons of hot water a week. The gas industry was, at that time, of the opinion that 150 gallons was enough, and the Abbots Langley field trials have since confirmed that this lesser amount was right. 150 gallons per week can be provided by gas for 2½ therms per week using instantaneous single point heaters and 3 therms per week by multi-point instantaneous or storage heaters. The various types of heater, their ratings and uses are given in Table 4.

TABLE 4.
GAS CONSUMPTION FOR NORMAL TYPE OF HOUSE OR FLAT AND FAMILY OF 4

Heat service	*Conditions*	*Therms/year*
Hot water (150 gal. at 140° F.)	All the year round	120—160
	Summer (22 weeks)	45—55
Cooking	If full separate hot-water service available	80
	If no piped hot water available	110
Laundry	Wash boiler	10—15
	Drying cabinet	20—25
Refrigeration		50—60
Space-heating	Bedroom fire	10—15
	Living-room—mild weather	30—35
	,, ,, —all the year round	200—250
	Dining room	25—35
	Background heater in hall	20—25

Appliances and systems (continued)

Present Position and Future Development of Domestic Heating Appliances Operated by Electricity

by E. M. Ackery, B Sc, M I H V E, of the British Electrical Development Association

to which has been added summaries of passages from a paper on "off peak and thermal storage heating," by J. W. Moule, B Sc (Eng.), M I E E, Deputy Chief Commercial Officer, South of Scotland Electricity Board.

The author begins by making the same point as that made by those writing on gas appliances, namely that heat loss calculations of the kind favoured by BRS are of little use in estimating the effects of intermittent heating. He then discusses the differing performances of fire bar and reflector type fires (giving a table for sizing) and of these as against the four main classes of low-temperature electric heater. In the course of describing the latter he makes the point that the cost of operating any heater (whether electric or not) on a thermostat depends not on the rating but on the heat loss from the room. At this point a section on thermal storage is interpolated from Mr. Moule's paper. This is mainly concerned with describing electric under-floor heating, but the point is also made that the thermal capacity of a conventional hot water system is such that it can be operated efficiently by an electric boiler operating at off-peak rates. Mr. Ackery then gives some calculated consumptions of electricity for background heating based on Dr. Weston's heat requirements for houses, and concludes with a discouraging reference to the future of the heat pump.

The problem of heating is not so much how to maintain a given temperature in a given space for a given period of time, but how to provide the householder with as much comfort as possible in a form he requires at a price he can pay. For this reason it is proposed to list the different types of electrical appliance now on the market and to discuss the performance of each.

Domestic Electric Heaters

Domestic electric heaters, as distinct from electric heating systems (which are considered separately) fall into two main classes: fires and low temperature heaters. Of all types of electric heater, the electric fire is by far the most popular. This may be partly because, when assessed on a heat-output basis, it is the cheapest in first cost, but is chiefly due to the fact that the kind of heat it gives is immediately and continually *felt.* Whereas low temperature heating is only felt when you first come into the room. Electric fires are of two main types: the *fire bar* type and the *reflector* type. Of these the fire bar type consists of a continuous coil laid in grooves formed in the surface of a moulded fireclay slab and gives off heat approximately in the proportion 50 per cent. by convection and 50 per cent. by radiation; whereas the reflector fire consists of a smaller heating element such as a rod or a tube fixed at the focal point of a curved and polished reflecting surface. As the heating element is smaller the fire develops its full output more rapidly (in 1 or 2 minutes) and this is given off in the proportion 70 per cent. by radiation and 30 per cent. by convection. These proportions are only of general validity: there are fire bar type appliances on the market which give off a higher proportion of radiant heat than some radiant fires. A good rule when comparing radiant fires of similar wattage is to remember that the physical size of the element is in inverse proportion to the temperature to which it is designed to be heated, and that therefore the fire with the smaller diameter bar is designed to burn to the higher temperature and will give out a higher proportion of radiant heat. In general it may be said that the fire bar type gives a warm room while the reflector type gives a comfortable fireside circle.

When calculating the size of fire it is important to realize that heat loss calculations are not a suitable means for estimating the effects of intermittent heating. For rooms other than living rooms the simple rule is 1 watt per cubic foot of room space, but in living rooms it is considered that higher wattages than these should be used. Suggested figures are given in Table 1, where those in column A refer to houses built to a pre-war standard of insulation while those in column B relate to houses built to the Code of Functional Requirements of Buildings.

TABLE 1.

Room floor area (8 ft. ceiling), ft.	*Size of fire, kW.* A	B
10 × 10	1·5	1·5
12 × 12	2·0	1·5
12 × 14	2·25	1·75
14 × 15	2·75	2·0
15 × 16	3·0	2·25

Since fires are not normally manufactured in fractions of a kilowatt the choice should be made of the next size up.

Low-temperature Electric Heaters

There are four main types of low-temperature heaters: tubular heaters, electric convectors, electric radiators (*i.e.* similar to the hot water type) and panel heaters.

Tubular heaters are circular or oval in cross-section and are made in lengths of from 2 to 17 ft. Their normal loading is 60 watts per foot run which gives a surface temperature of about 200° F. They are commonly used at skirting level, singly or in banks of two or three, and are particularly useful for stopping down-draughts under windows or skylights. They have a low thermal capacity and heat up quickly in 10 to 15 minutes: their surface finish affects their efficiency and metallic paints should be avoided. About 27 per cent. of their output is given off as radiation.

Electric convectors are manufactured in loadings ranging from 0·75 to 3 kW.: they may operate either by natural draught or by fan and they may be fitted with a thermostat. They give out all but about 8 per cent. of their output as convection. Their thermal capacity is low and they therefore heat up quickly: of the natural draught type it may be said that those that give a large quantity of warm air at low velocity and moderate temperature are to be preferred to those which give a small quantity of air at high velocity and high temperature.

Electric radiators are in effect radiators of the ordinary central heating type fitted with an electric heating element. The heating medium may be steam or vapour, hot water or oil. As they have a relatively high thermal capacity they have the characteristics of continuous as against intermittent heaters: they take relatively longer to heat up and to cool off. Loadings vary between 0·75 and 3 kW. and surface temperatures from 120° F. to 180° F. The proportion of radiation varies according to the position in the room: a radiator standing against a wall will give out about 15 per cent. and one free-standing in the room about 50 per cent. by radiation.

Low-temperature panel heaters consist usually of a non-metallic panel enclosing an electric heating element, and may be free-standing and portable or fixed into the wall with an insulated backing. Loadings vary from 80 to 180 watts per sq. ft. and surface temperatures from about 120° F. to 250° F. Once more the output of a panel much depends on its position: if it is free-standing it will give off as much as 55 per cent. by radiation, but if it is fixed to a wall with an air space behind, this proportion is reduced to 28 per cent. as radiation from the back is at once converted to convection.

There is an important difference to be noted in the operation and the cost of running an electric fire and any form of heater which operates on a thermostat: namely, that with the former the consumption of electricity is determined by the hours of use and the rating of the appliance, while with the latter consumption depends on the heat loss in the room. Thus a heater larger than is necessary for a given job will use no more electricity than one which is just large enough and although switching off at night will reduce consumption it will not do so in proportion. Thus to switch off for eight hours out of 24 will reduce consumption by very much less than one-third.

Heating Systems

Heating system is a term which applies essentially to installations where the whole house is heated by a single source, or where large areas are heated by elements built in to the structure. In the former class come the various types of electric boiler which may be used to operate conventional radiator systems and the latter includes heating by means of elements embedded in floors and ceilings.

Electric boilers can be of the immersion type or the electrode type and when used for space heating, as distinct from hot-water supply, are seldom used in new houses since individual low-temperature heaters are more flexible in control. On the other hand, it is possible to make use of the thermal capacity of a conventional hot-water system to use off-peak electricity rates. Thus in the South of Scotland there is an off-peak tariff for current which is disconnected for two-hour peak periods (*i.e.*, 8-10 a.m. and 3-5 p.m.), giving a saving of 0·2d. per unit: interruptions of this order cause little temperature drop on the average hot-water system.

Granted that block storage heaters are not permitted for domestic use, there remains electric floor warming. Electric cables are either run in tubes bedded in the floor (the more expensive method, which has the advantage that the cables can be drawn out in the event of failure) or are buried directly in the floor. They are usually laid out to produce a maximum floor-surface temperature of 75° F., which as a general rule requires a loading of between 10 and 12½ watts per sq. ft. of floor area. The most important use of this method to date is in the block of flats built by Kirkcaldy Corporation, where 48 flats are provided with this form of heat in the living room and hall. Here the maximum floor temperature is 72° F. and each living room is provided with an electric fire for use during the summer and during cold snaps. The calculated weekly costs of maintaining this temperature (and of the other electrical services) are given in Table 2.

TABLE 2.

Service	*3-apt. flat.*	*2-apt. flat.*
Hot water	4s. 9d.	2s. 5d.
Floor-heating	6s. 5d.	5s. 3d.
Extra electric radiator ..	2s. 10d.	2s. 6d.
Cooking	1s. 11d.	1s. 5d.
Lighting, etc.	1s. 9d.	1s. 3d.
Total	17s. 8d.	12s. 10d.

Where a heating system is used to maintain a certain temperature continuously during a heating season it is possible to estimate the consumption on the heat loss/degree day method described by Dr. Weston. The calculated consumption in kW. for four different types of building constructed to three different standards of insulation and providing 50° F. and 55° F. are given in Table 3. In this the left-hand column of figures relates

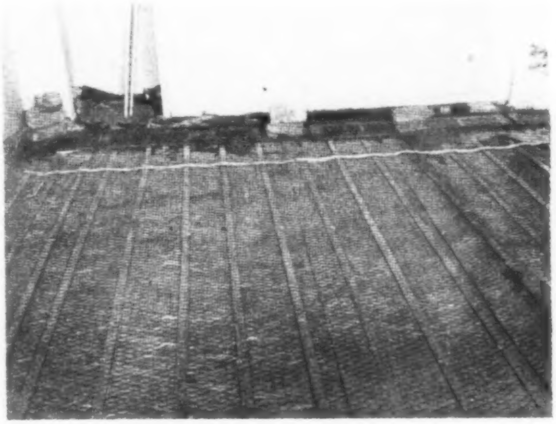


Fig. 1. Floor heating equipment just before laying of top concrete screed.

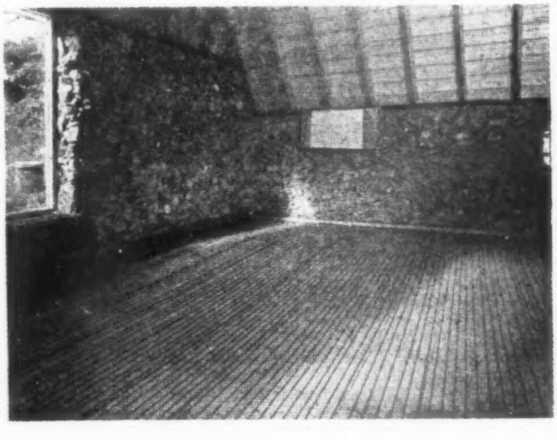


Fig. 2. Layout of solidly embedded heating cable before application of top concrete screed.

to a building with a "high" standard of insulation, the middle column to a medium, and the right-hand column to a low standard of insulation. The precise definition of these standards is given on page 741.

Hot Water Supplies

With electrical equipment there is no case for using one appliance for both space and water heating. It is relatively common, however, for people to install an electric immersion heater (usually 3 kW.) as an auxiliary to a solid-fuel boiler for summer use. When this is done it is essential that the immersion heater should do no space heating, that there should be no risk of back circulation of electrically-heated water through the solid-fuel boiler, and that pipe runs should be short. If pipe runs are long, for instance, between the storage tank and the kitchen sink, it would probably pay to install a 3-gal. 1-kW. self-contained sink water heater. Where a single self-contained heater is used for all water heating in a house a useful version is the "two-in-one." This has a 500-watt heater in the top which is kept on all the time and is sufficient to heat the 5 or 6 gal. of water needed for casual use, and a 2½-kW. heater at the bottom which is turned on for baths and which is capable of heating the entire contents (usually 20 gal.).

The Heat Pump

The one item of electrical equipment which evades the ordinary electrical rule of one piece of equipment one function is the heat pump, which (in the only form in which it is now commercially available in this country) is used to cool a larder and provide either hot water or a small amount of space heating. The justification for this is that the amount of useful heat obtained is between 2½ and 3 times that which would normally be produced by the amount of energy put in. Unfortunately, we still have insufficient evidence of the effectiveness of these appliances in use: there is some doubt whether the larder will at all times be kept below the 50° F. which is the maximum safe temperature for storing perishable foods, and whether the heat pump can keep up an adequate supply of hot water in cold weather without over-cooling the larder.

In this country we have still to wait for a commercial application of the heat pump for whole house heating. Inherent disadvantages seem to be that the lower the outside temperature the poorer the performance, with the result that the plant installed has to be of relatively high capacity and hence expensive, and the substitution of a piece of moving machinery for the conventional boiler or heater with no moving parts.

TABLE 3.

CALCULATED CONSUMPTION OF ELECTRICITY FOR CONTINUOUS BACKGROUND HEATING TO 50° F. AND 55° F., IN KWH PER HEATING SEASON OF 210 DAYS

Flat on intermediate floor, ordinary construction	50°	5,620	7,500	9,820
	55°	11,800	14,800	18,650
Flat on intermediate floor, good construction	50°	4,760	6,490	8,620
	55°	10,350	13,200	16,650
Terrace house, ordinary construction	50°	9,050	12,000	15,250
	55°	17,200	22,200	27,500
Terrace house, good construction	50°	6,720	9,050	11,800
	55°	13,600	17,400	21,700
Semi-detached house, ordinary construction	50°	9,750	13,050	16,650
	55°	18,100	24,100	29,750
Semi-detached house, good construction	50°	7,080	9,750	12,650
	55°	14,150	18,550	23,100
Detached house, ordinary condition	50°	10,800	14,100	18,100
	55°	20,200	25,600	32,000
Detached house, good construction	50°	8,000	10,450	13,600
	55°	15,650	19,600	24,600

* Weston, J. C., Heat Requirements of Houses. *J. Instn. Heat. Vent. Engrs.*, 1950, **18**, 185.

Appliances and systems (continued)

Central Heating Systems

by H. H. Bruce MIHVE, Technical Director, Invisible Panel Warming Assn.

After pointing out that BRS tests on unoccupied houses have shown that central heating systems produce higher mean house temperatures at lower cost per degree rise, and after discussing certain general rules for obtaining comfort conditions, the author proceeds to the main purpose of his paper which is to describe and discuss six different ways of installing central heating in the typical semi-detached house which was the subject of Broughton and Nash's cost studies reported on page 741. Mr. Bruce concludes by putting the case for partial central heating with a back boiler and radiators and for district heating for compact blocks of 50 houses.

When, during the winter of 1947-48, the Building Research Station carried out tests in which ten pairs of unoccupied semi-detached houses were heated and serviced by ten different combinations of equipment, there were included four central heating systems: three of these giving full heating and one giving background heating only. The three central heating systems giving full heating gave higher mean house temperatures than the other seven. Further it can be shown that there annual cost (including amortization) expressed in pence per degree rise in mean house temperature was less than any of the other seven. It is true that these central heating systems gave also unnecessarily warm bedrooms and kitchens, but both these defects could be put right by varying the design: they do not vitiate the essential economy of the method.

One of the facts which has emerged so far from the further BRS tests on the houses when occupied is that there is no case for permanent heating in the bedrooms. Provided the roof is insulated to a U value of not more than 0·20, stray heat from the warm rooms downstairs will generally maintain bedrooms at 45°—50° F. in cold weather. Another point which emerged was the need for heating in kitchens: in four of the houses under test, where there was no heating other than that given off by cookers or water heaters there were complaints, the average temperatures being 58—59° F.

The effectiveness of central heating systems in producing comfort conditions depends on design. Heating surfaces should be placed to offset local heat losses and to warm incoming cold air. Radiators should be placed under windows and should extend the full width of the window: the thin, flat wall type is more efficient than the multi-column type. The experiments of F. J. Vernon showed that, whereas a radiator placed under the window and designed to

the same width as the window produced a temperature gradient of only 2° F., a column radiator placed beside the window produced a gradient of 18° F. Skirting heating produces very little temperature gradient, while floor heating produces a *negative gradient*. An important point to be noticed in assessing central heating systems is that the ordinary thermometer is only slightly affected by radiation. It is for this reason that mainly radiant sources can produce comfort conditions with an air temperature of 65° F. while the same conditions are only produced by mainly convective sources when the air temperature is raised to 68° F.

Another point to be watched with radiant heating is the need to avoid discomfort at head level. F. A. Chrenko showed, and A. Missenard confirmed, that discomfort is caused by the *difference* between globe temperature (*i.e.* the temperature of a surface produced by radiation) between the head and the foot, rather than by the intensity at head level. Thus it is that a large panel may present less risk of discomfort than a small one at the same temperature since a large panel will raise the temperature of the floor beneath. Glazed doors in external walls or windows reaching down to the floor will always make draughts hard to prevent since they do not leave room for high temperature heating surfaces to be placed beneath them. A floor panel with weather-stripped frames will reduce risk of draughts, but if the floor surface temperature must be limited to 80° F. draughts are liable to be felt up to 3 ft. away in cold weather. Alternatively a ceiling panel may be used to warm the floor immediately below to a temperature of 70° F. with an air temperature at 65°F. provided the floor U value is not greater than 0·15.

Floor Finishes

With radiator, skirting and ceiling heating systems, insulating floor finishes such as wood blocks, cork tiles and carpet give the best results, not so much on account of any improvement in U value they may give as because they heat up more rapidly.

With under-floor heating, on the other hand, an insulating floor finish is a disadvantage: first because it requires a higher water temperature in the pipes to produce the same surface temperature, and second because it increases the irrecoverable heat loss downwards. Though this last is confined to an area 3 ft. from the outside walls it is usually a considerable factor in an ordinary house. The downwards heat loss is calculable by subtracting the outside temperature from the screed temperature. The effect of different floor finishes on downwards heat loss can be seen in Table 1. There are other factors which make for the conclusion that if the occupier wants wood block and carpeting in the living room then he should not have underfloor heating. Namely, if the living room floor finish has a greater thermal resistance, it will require a higher water temperature. Again the maximum floor surface temperature allowable for a wood block floor is 80° F. This with a room temperature of 65° F gives

TABLE 1
DOWNWARD HEAT LOSS WITH FLOOR-HEATING IN HOUSES (EXPRESSED AS A PERCENTAGE OF UPWARD EMISSION)

Floor finish	Downward loss, per cent: With 1 in. cork under screed	Downward loss, per cent: Without insulation
Lino, thermoplastic tiles, PVC sheet or tiles, on screed	15	25
Wood block, wood strip, $\frac{3}{16}$-in. cork tiles *or* close-fitting carpet and underfelt on screed	22½	35
Wood block *and* close carpeting	30	45

Note.—With other methods of heating the floor heat loss would be 10 to 15 per cent, depending on the *U* value for the floor and the way the system is operated.

TABLE 2
HEAT REQUIREMENTS OF REPRESENTATIVE HOUSE

	Air change	*U* Values: Wall	*U* Values: Floor	*U* Values: Roof	Temperature maintained, deg. F.	Btu.
Living-room	2	0·25	0·15	—	65	6,750
Kitchen	2	0·25	0·2	—	60	2,750
Hall and stairs	2	0·25	0·2	0·15	60	4,500
Bedroom 1	1½	0·25	—	0·15	55	2,000
Bedroom 2	1½	0·25	—	0·15	55	1,750
Bedroom 3	1½	0·25	—	0·15	55	1,500

a maximum upward heat emission of 30 Btu/hr./sq. ft. which may well not be enough in cold weather. With types of floor finish other than wood block it is often practicable to design for a narrow strip of floor at 90° F under windows where greater heat is wanted and where it will not cause discomfort to feet.

Comparison of Systems

As part of the preparations for the Conference, BRS selected a typical semi-detached house plan, determined the U values of walls, floor and roof, the air changes to be allowed and the temperatures to be realised, and asked a number of heating engineers to design five different systems to fulfil the conditions. The requirements are laid down in Table 2, the systems are described and their estimated costs given in Table 5 on page 744.

Conventional Radiators (Figs. 1, 1a).

Figs. 1 and 1A show the first system which uses conventional radiators placed wherever possible under windows. Circulation is by gravity with 2 in. flow riser to the roof space and 1¼ in. drops. Two of the ground floor radiators are *not* under windows and would need shelves over to prevent blackening, vertical runs are exposed to view but are placed against window frames to be less conspicuous. They will, of course, dirty walls and ceilings. Approximately 55 ft. run is in the roof space, causing a heat loss of about 10 per cent. An alternative might have been to run the floor main at ground floor ceiling level: this would have saved the heat loss into the roof, though it must be admitted that this heat loss contributes towards gravity circulation head. Ground floor radiators should be several inches clear of the floor.

Close-coupled conventional radiators (Figs. 2, 2a).

This system likewise uses conventional radiators, but they are close-coupled. This saves pipework but may give rise to temperature gradients and thence cold draughts at the floor. Generally speaking this system is only advisable when the domestic boiler is only large enough to heat *one* close-coupled radiator.

Skirting Heating (Figs. 3, 3a).

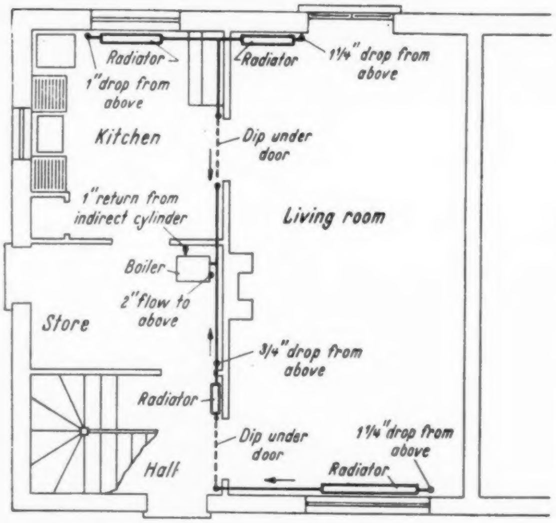
Skirting heating requires a pump. In this case radiant or plain skirting heaters are proposed and not the type with air circulation passages. Since the heat output is small per foot run,* long runs are needed, and much of it has to be in relatively unstrategic positions (*e.g.*, there is more against the party wall than against the external wall). Nevertheless, conditions should be very comfortable. Ordinary radiators are proposed for kitchen and hall.

Floor Heating (Figs. 4, 4a, 4b, 4c).

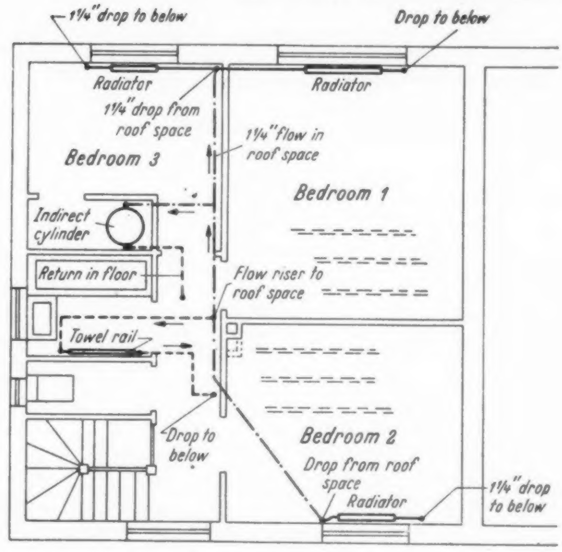
Floor heating pipes are ⅜ in. bore, 19 gauge, soft copper tube to BS 1386-1947 in long lengths so that joints occur only at the headers near the boiler. An alternative would have been ½ in. (nominal) bore Class C steel tube. These are 10 to 20 per cent. cheaper than the smaller bore copper panels, but would cost at least as much in the present instance since much site welding would be necessary. Both need a pump.

The hottest pipes are those nearest the outer walls of the living room. If, as is likely, the floor finish in this room has a greater thermal resistance than that in the kitchen, the kitchen may get too warm. To avoid this the pipes heating the kitchen may be given a reduced circulation or a lightweight topping be added to the kitchen screed.

*Approx. 200 Btu/hr. per ft. run at ordinary radiation temperatures.

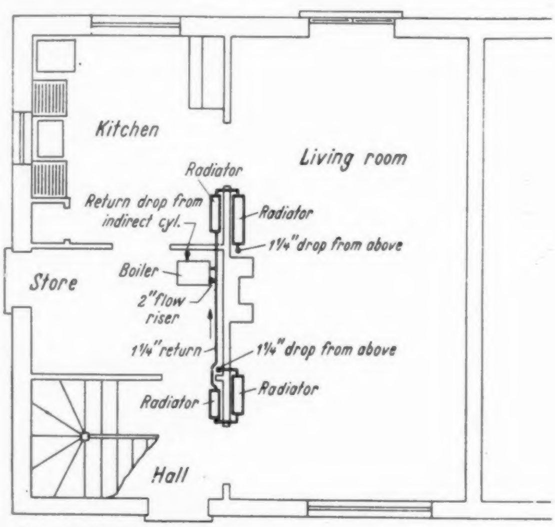


Ground floor plan

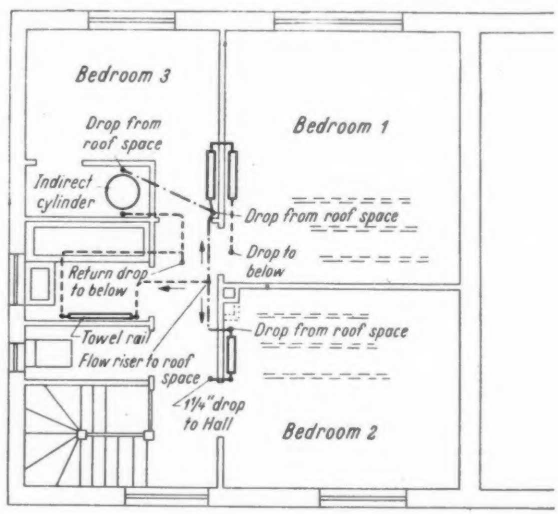


First floor plan

Figs. 1 and 1a. Radiators under windows.

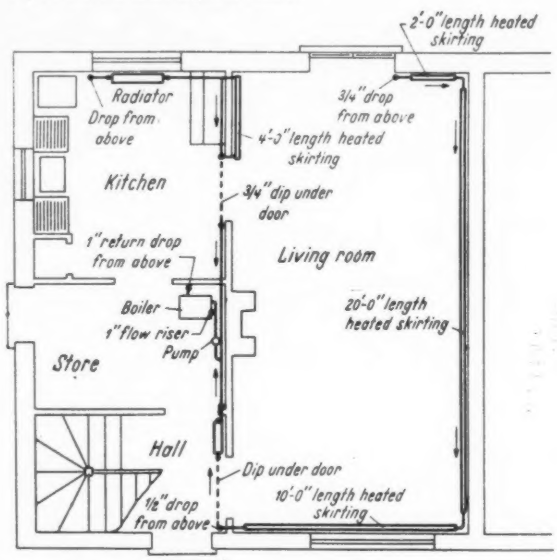


Ground floor plan

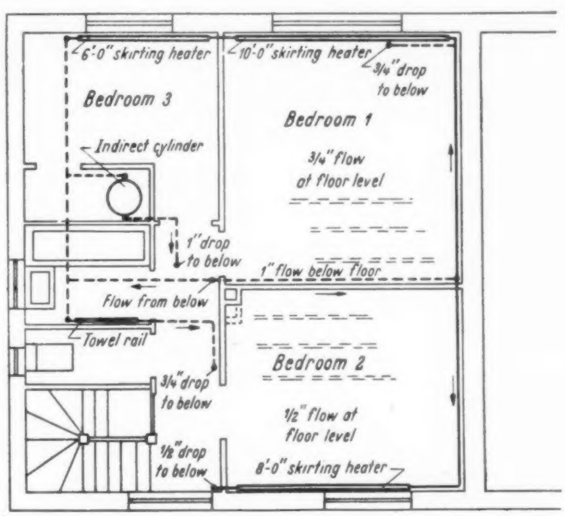


First floor plan

Figs. 2 and 2a. Close-coupled radiators.



Ground floor plan



First floor plan

Figs. 3 and 3a. Skirting heating.


Additional lighting points . . .
A convenient way of obtaining natural light in a roof space is to specify the use of a number of Pilkington's Glass Tiles or Slates in the roof. They are made in patterns to match all standard types and sizes of tiles and slates. (Details on request).
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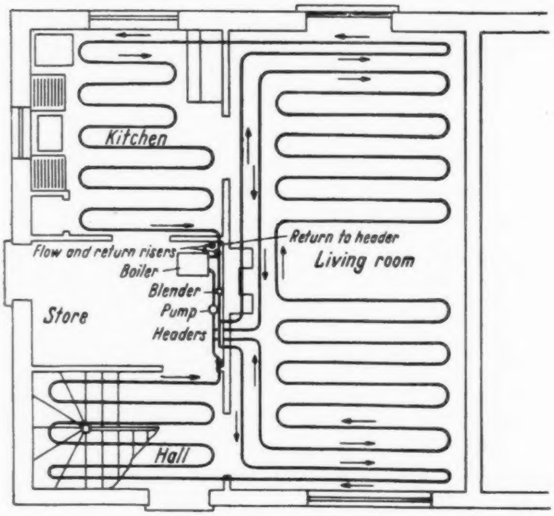
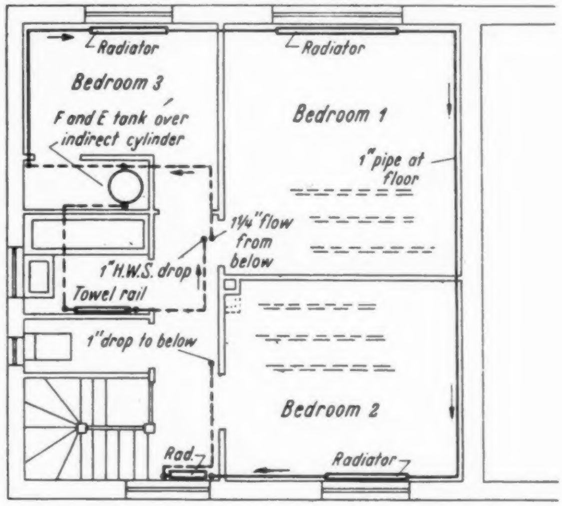


Ground floor plan [Scale: 1/8" = 1' 0"]



First floor plan

Figs. 4 and 4a. Floor heating.

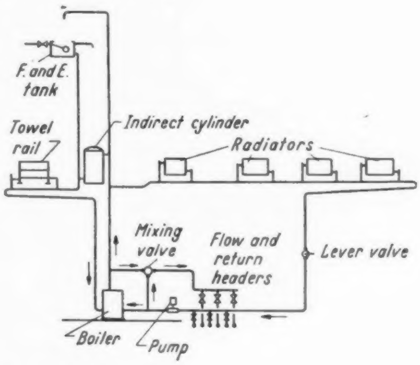


Fig. 4b. Heating circuits.

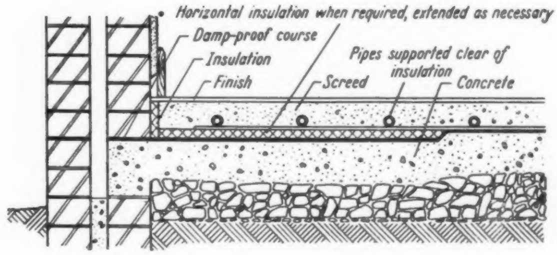
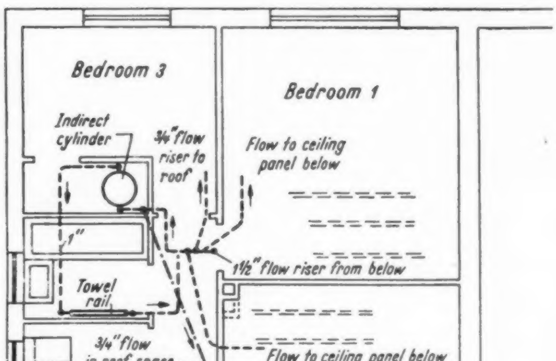


Fig. 4c. Floor heating, showing method of laying pipes.

Ceiling Heating (Figs. 5, 5a, 5b)

There are five embedded panels in this system: three in the ceiling of the ground floor, one in the ceiling over the landing, and one floor panel in the hall. The panels are delivered ready made from ½-in. (nominal) bore steel tube. Circulation is by gravity requiring a flow temperature of 140° F. in cold weather. The one floor

Ground floor plan [Scale: 1/8" = 1' 0"]



First floor plan

Figs. 5 and 5a. Embedded ceiling panels.

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Setting by Heal's.

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The Parkray 2 (which has a back boiler) has an overall efficiency of over 50% on coal and about 65% on coke. It will heat a room up to 2,000 cu. ft. capacity on an average weekly fuel consumption in winter of 1½ to 2 cwt. — no more than is burnt on an ordinary open fire at an efficiency of 25%.

The Parkray 2A is the non-boiler model of the same fire, which will heat a room up to 3,000 cu. ft. (Egerton standard of insulation: 3,500 cu. ft.)

Yes, the Parkray has an exceptionally high heating efficiency. Why? First, because it has a specially designed down-draught firebox. Second, it is fitted with an adjustable throat restrictor which reduces the volume of heated air normally lost up the flue of a traditional open fire by 75%. And here is a further reason—the constant flow throughout the room of convected warm air. To these you can add the convenience of gas ignition for trouble-free fire lighting and the shaker grate which dumps the clinker and stones without trouble.

Design for a domestic hearth

Parkray convector fires open up new possibilities for a modern, well-designed hearth. They need only a simple recess for installation — brick, stone, tiled cast iron or rendered in tinted cement — so they free the architect from the limitations imposed by the tiled surround. They combine the most efficient convection heating with a handsome, modern design.

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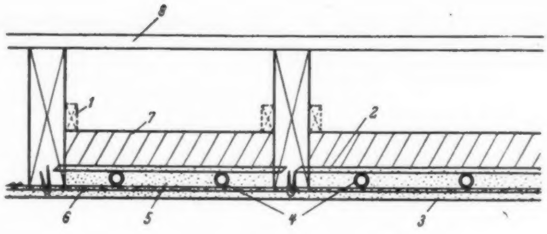
1. Fillets, required if pugging to be applied from below.
2. 1¼ in. × ¼ in. flat bars cut into joists.
3. Floating and setting coats.
4. Pipes at centres to suit joist spacing, wired to flat bars.
5. Pugging.
6. Expanded-metal lath.
7. Insulation.
8. Floor boards.



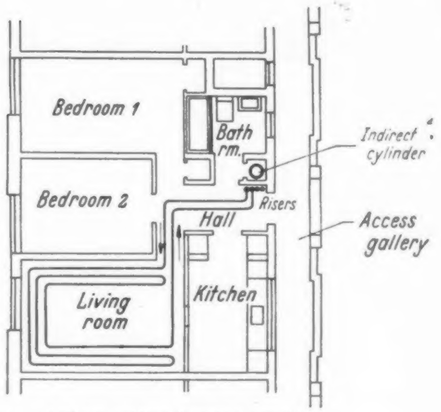


Fig. 5b (above). Embedded ceiling panels, showing method of laying pipes. Fig. 6 (right). Embedded panel ceiling heating over living room in multi-storey block of flats.

panel and the landing ceiling panel are connected in series since by this means it is possible to site the floor panel *below* the boiler and still use gravity circulation. If small-bore copper panels had been used a pump would be necessary. Where ceiling pipes run parallel to the joists the latter are notched at their ends to receive them; where ceiling pipes run at right angles to the joists the ceiling is firred down 1½ in. The pipes are embedded in 1¼-in. pugging (sand/lime/cement mix) supported on metal lathing. Plastering is delayed 10 days, plaster being composed of a sand/lime mix gauged with plaster of Paris. The upper surface of the pugging must be well insulated or the bedrooms will get too hot in mild weather. Panels should not be wider than 7 ft. 6 in. and longer than 12 ft.

A variation of the last system, following substantially the same layout as shown in Figs. 5 and 5A, is "hollow ceiling heating" where pipes are not embedded but are run in a space below or between the joists. Pipes are rather larger than when embedded and water is circulated at higher temperatures (*i.e.*, as with normal radiators) and by gravity.

Hot Water Supply

With each of the systems described there is a separate circuit to an indirect cylinder in the linen cupboard. In the case of the two systems which have a pumped circulation a constant flow temperature can be maintained in this circuit (of, say, 160° F.) and the heating flow can be varied at need. This requires thermostatic control of the boiler draught and a thermostatically-controlled three-way valve to blend the heat flow. This is usually set by hand. It is not advisable to apply the same control to the indirect cylinder circuit. The same mixing device *can* be installed on gravity circuits, but only at the sacrifice of gravity circulating head which cannot usually be spared with ground-floor radiators and can be spared with ceiling panels only if expensive "grid coils" are used.

One way of operating gravity systems is to put a quick-opening lever-operated valve on the heating circuit. This may then be closed for half an hour or so to boost the temperature in the indirect cylinder circuit; but a more usual method is to install an immersion heater which can both "top-up" when wanted and provide hot water when the boiler is not in use.

Back-Boiler Systems

Leaving the schemes which are the main subject of this article and considering the feasibility of running a small amount of central heating off a back boiler, it is to be noted that appliances are now available which can achieve a direct space- and water-heating output of about 20,000 Btu/hr. at an efficiency of 55 to 60 per cent.

The following is typical of the output of such a boiler:

	water heating	*space heating*
Damper open	15,500 Btu/hr.	7,000 Btu/hr.
Damper closed	10,500 Btu/hr.	8,000 Btu/hr.

As the water heating output is much greater than a normal small family will want most of the time there is evidently a case for providing, say, one small radiator in the kitchen and another in the living room, run off the return from an indirect cylinder on the first floor. An alternative might be to use two hollow ceiling panels, which need not be run off the return.

A back boiler is, however, an inefficient means of providing hot water in summer: it is a nuisance and working efficiency drops to 25-35 per cent. Since this is so there is a case for providing *all* hot water by gas or off-peak electricity and for using the full output of the solid-fuel appliance for space heating, perhaps in conjunction with hollow ceiling heating panels.

Central Heating in Flats

Attention is drawn to an application of embedded-panel ceiling heating over the living rooms in a multi-storey block of flats (see Fig. 6) where the installation cost, including builders' work, came out at less than for an equivalent radiator system.

Each house had an indirect cylinder for hot water and the calculated weekly charge (living room 60° F., hall 50° F. with outside temperature 30° F.) was 11s. 9d., of which about 36 per cent. was interest (at 5 per cent.) on capital expenditure.

District Heating

The case for providing "District Heating" to a compact block of 50 houses is almost as strong as for a block of 50 flats. A typical installation might be as follows:

A basement heating chamber under one house accommodating two boilers, each of rather less than 1 million Btu/hr. each capable of supplying two-thirds of the maximum total demand, coke or oil fired.

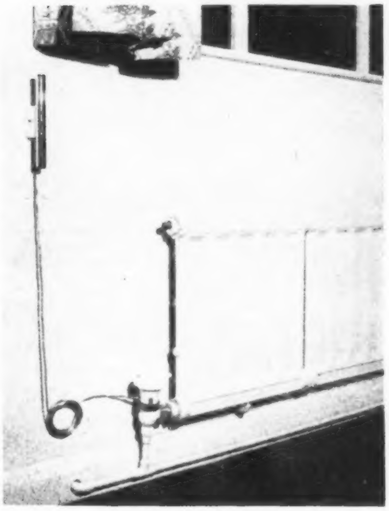
A stack which need not rise more than 4 ft. above the ridge.

Two circulating pumps.

Three-pipe distribution in a ring trench incorporated in the footings where run below the houses. Separate flow for space heating and "Rationing-type" indirect cylinders and common return main.

The capital cost would doubtless exceed that of the 50 fireplaces, chimneys, fuel stores, etc., but it would allow bulk purchase coal at 116s. (11,500 Btu/lb.) per ton in place of 161s. 6d. per ton (January, 1956) or fuel oil at 230s. per ton (19,000 Btu/lb.). It is calculated that the cost of heating and hot water with the first of these fuels would be 7·9d. per therm, with the second 9·6d. per therm.

Appliances and systems (continued)



Separate radiator control on small pipe heating.

Automatically Controlled Small-pipe Central Heating

by S. A. Burke, B Sc, Ph D, M Inst F, Superintendent, Domestic Appliance Department BCURA, D. V. Brook and G. H. Bye, B Sc, members of the Domestic Appliance Department BCURA

This paper, which follows that of Mr. Bruce, describes a form of central heating by hot water which is being developed by BCURA. In this system water is circulated through small-bore pipes with an automatic pump, resulting in less interference with finishes, less heat loss from pipes and more ready control. The authors then discuss the question of thermostatic control and give the results of some field tests carried out by BCURA on six occupied detached houses using the small pipe system controlled by three different methods; that is, by room-, radiator-, and outside-thermostat. They conclude by showing that the last of these is the most effective and that the added expense would be recouped on one year's running.

The chief initial advantage of central heating is that nearly all modern central heating boilers work at an efficiency of 65-70 per cent. and generate heat from coke at a cost of about 11d. per therm. Their chief disadvantage is that a considerable proportion of this heat is dissipated by the fairly large pipes which are required to carry the water through the house by gravity circulation. This heat is given off not only in unoccupied rooms but in the roof space and beneath the ground floor. Further, with gravity circulation there is no easy way of reducing the heat in the radiator system as a whole without at the same time reducing the domestic hot water supply below the 140° F. which this requires. Therefore in milder weather radiators are either hotter than they need be or have to be turned off completely.

The object of this paper is to describe a system of central heating which uses small pipes and a circulating pump to diminish these disadvantages; and describes also tests carried out by BCURA in six trial houses near Leatherhead during the winter of 1955-56, when various types of control were used with this "small-pipe" system.

A typical layout of the systems used in the tests is shown in Fig. 1. Points to notice about this layout are:

1. Hot water is supplied by an indirect cylinder which is connected to the boiler by gravity circulation and lagged. Thus the drawing off of hot water affects the central heating system as little as possible.
2. The central heating system is provided with a boiler by-pass and valve (manual or automatic) and is thus an independent closed circuit into which more hot water is let as and when required. Boiler temperature is controlled at 170° F.
3. Two circuits are shown: in circuit No. 1 the pipe rises to the first floor skirting board and returns via the ground floor circuit, in Circuit No. 2 flow and return run behind the same ground floor skirting: in neither is there any piping in the roof space or under the ground floor. In this connection it is calculated that an equivalent circulation system, with 40 ft. run of 1¼-in. pipe in the roof and as much again under the floor, dissipates some 2,600 Btu/hr. in these places even when lagged. This represents 4s. per week in cold weather, or ½-ton of coke during a heating season. With this system pipes are virtually wholly within the rooms, and as their radiant surfaces are so much less, heat is concentrated to a greater extent in the radiator, which is, of course, placed where heat is most wanted.

Methods of Control

One of the early tests on the system was to discover whether it was practicable for the householder to control temperature by adjusting the by-pass valve manually. Though control by this means was found to be easier than with a gravity system it was found to be too great a nuisance and experiments were therefore turned to various forms of automatic control. The first method of control was by room thermostat connected with the pump motor circuit. The main difficulty with this method was that of finding a suitable place for the thermostat: no circulation space is suitable owing to the number of doors which open on to it, while if it is placed in a room the heating in this room must be kept on continuously whether the room is in use or not. Again, the continual use of a radiator for control purposes only throws an added load on the overnight burning of a boiler and may result in the use of a larger rating than would otherwise be necessary. Another disadvantage attaching to this method is that occupants have only to throw open a window in the room with the thermostat in order to cause overheating in every other room. Nevertheless, with all the disadvantages, this form of control is reasonably efficient, as can be seen in the graph in Fig. 2, and maintains even room temperatures with large outside variation. A small additional disadvantage is, however, found in the fact that the pump is "off" for longish periods, and therefore anyone wanting to turn a radiator on at the

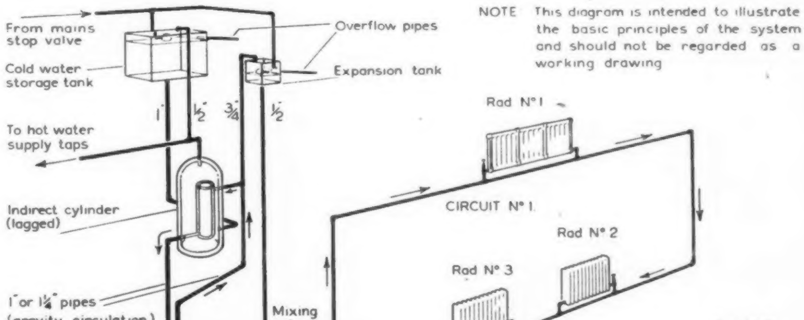


Fig. 1. Small pipe, forced circulation central heating combined with hot-water supply.

beginning of one of these periods would have a long time to wait before getting any heat. Lastly, there are other technical objections arising from the on/off action of the pump, the consequent sudden drops in flue temperatures (see the top of the graph) and the sudden switching of the full boiler output on to the indirect cylinder circuit.

The second method of control used was that of attaching thermostatically-controlled

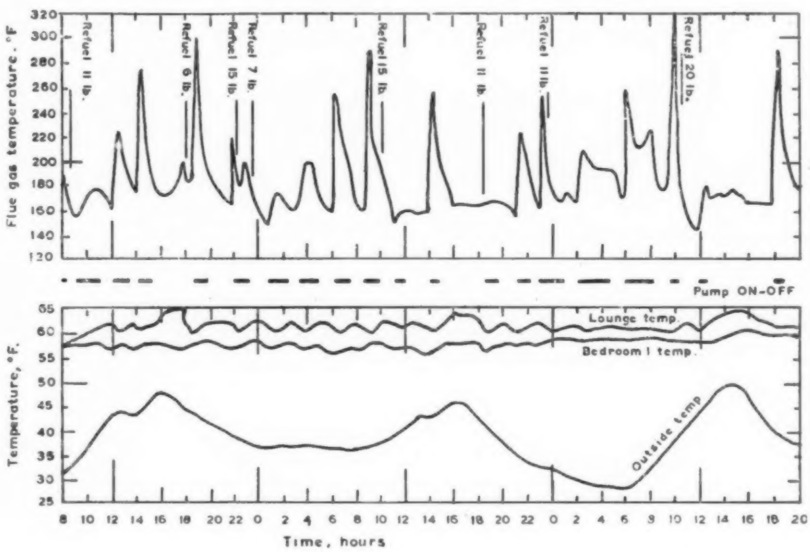


Fig. 2. Control by room thermostat in pump circuit.

radiator valves to each radiator. By this means it is possible to control each room separately, uninfluenced by events in any other room. The most serious defect of this method is that it leaves the heat emission from the pipes completely uncontrolled. This in a gravity circulation system could easily account for as much as 50 per cent. of the total, but in a small pipe system was found to account for 25 per cent.: with all radiators on and a boiler flow temperature of 180° F. the pipes in the latter gave a heat emission of 8,000 Btu/hr. out of a total of 32,000 Btu/hr. In warm weather the pipes alone can easily make a room unpleasantly hot (and thence occasion heat loss) particularly in the kitchen where pipes usually converge. This is, of course, a strong argument for a method of control which will reduce the temperature of the water in the pipes, and in fact experiments showed that an average heat emission could be cut from 8,000 Btu/hr. to 2,900 Btu/hr. by this means.

The third and last method of control to be tried was to control the mixing valve (and hence the temperature of the water) by outside thermostats. Equipment for doing this to large buildings has long been commercially available but it was necessary to develop a special device for small buildings. This is described in the diagram in Fig. 3. In this A is the pump, B the boiler, and C the by-pass. G is a bulb in the outside air which contains fluid which contracts when the outside temperature falls. Fluid is thereby withdrawn from the chamber H with the result that the nozzle J is unstopped. Water is then drawn up K to build up pressure behind the bellows E causing the valve D to drop and allow a greater proportion of hot water to flow across the pump. The hotter water passing round H causes the fluid in this bellows to expand and hence to stop up J. The volume of the outside air bulb G is related to the volume of the chamber H so that the change in water temperature bears the desired relationship to the corresponding change in outside air temperature. One important refinement is the inclusion of the manually-operated valve M which enables the householder to get the full boiler temperature when he wants the house heated up quickly, regardless of what has happened to J.

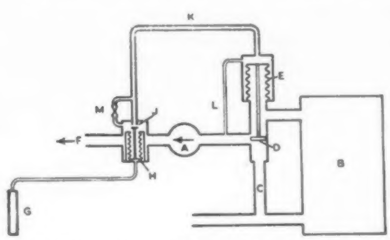


Fig. 3. Device for control by outside air temperature.

The use of this control raises the problem of how to set it. The setting will, of course, vary with the room temperatures required. The graph in Fig. 6 shows four curves corresponding with four typical room temperatures. The upper of the two horizontal scales shows the outside temperature range and the lower horizontal scale shows the corresponding room temperatures in an *unheated* house. The vertical scale shows the flow temperatures in the pipes, and the dotted line at the foot of each curve shows the point at which the pump should "cut off" for the inside temperature in question. Thus to maintain a room temperature of 60° F. the pump should cut off when the outside temperature rises above 50° F. and should turn on again when it drops below 50° F.

This mechanism has been on test in three trial houses. The results of one of these tests are given in Fig. 5, which shows a week's working. In the house in question the bedroom radiators had been sized to give a temperature of 55° F., those in the lounge and dining room to give 60° F.—on the assumption that a fire in the lounge would raise the latter to the required 65° F. The controls were set to lower the mixed flow temperature by 5° F. for every 1° F. rise in outside temperature (*i.e.* between curves 2 and 3 in Fig. 4). Bedrooms 1 and 3 were heated continuously, but the radiators in the other rooms were turned off during the night. It will be seen that the temperatures of all rooms except the lounge were well up to the design temperatures, but that the heating in the lounge not only failed to produce the desired 5° F. above the 60° F. to be given by the radiator, but did not even reach the 60° F. before about noon each day. The reason for this was found to be an excessively high air flow up the chimney, amounting to as much as 13,000 cu. ft./hr. when the fire was burning at a low rate and only a small fanlight was open. The system was designed on an assumed air rate of 2,500 cu. ft./hr. and the extra air flow could require over 5,000 Btu/hr. in addition, which equals the

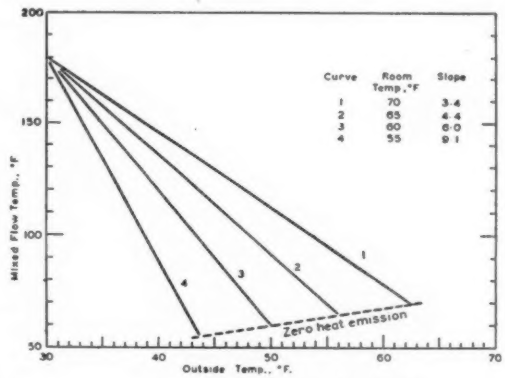


Fig. 4. Controller characteristics required for different room temperatures

entire heat output of the lounge radiator. The moral of this is that in houses with central heating only free-standing convector fires with restricted throats should be used. The sudden temperature drops in bedrooms 1 and 3 correspond to periods when the window was open. Apart from these hazards it is evident that the system of control is in fact efficient. The controller itself is not yet commercially available, but it is calculated that when it is it should cost about £15.

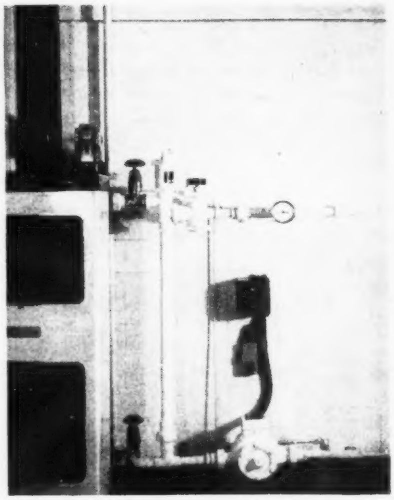
Fuel Savings Due to Control

Tests have been made at BCURA in order to find out how much fuel is saved by each type of control. Though clearly much must always depend on the habits of the occupants, the resulting figures are valuable as they give a rough guide to how much a householder might reasonably be able to afford on a control system. The results given in Table 1 relate all to houses with a total rated output of 24,000 Btu, to which must be added 8,000 Btu for the pipes. The average number of radiators on at any time was two, giving an average output (with the pipes) of 16,000 Btu/hr.

The first set of figures in the table refers to the uncontrolled use of the boiler at 180° F.: but a householder who was out to use his system economically would not maintain so high a temperature, and the second set of figures therefore assumes that the householder would reduce the *boiler temperature* to 150° F. in warm weather, and all the reduction of fuel costs in the last column represent savings on fuel which the maintenance of this lower temperature would require. At the same time it must be pointed out that with a boiler temperature of 150° F. you can only draw one hot bath and that if the temperature were to fall below 150° F. you might not even get this.

The next two sets of figures represent the results of applying automatic control by means of a room thermostat: in the first place without keeping the room where the thermostat is placed perpetually heated for control purposes, and in the second by placing the thermostat in the dining room and by keeping that room heated for an extra ten hours every day. The last set of figures but one shows what happens when control is by means of thermostats attached to each radiator (a method of control which costs the most and saves the least) and the final figures show the effect of using the outside thermostat and by-pass valve.

These results show that the savings gained by controlling radiators alone are considerably less than those gained by controlling the flow temperature in the pipes. It suggests also that since fuel savings by controlling the flow temperature amount to between £15 and £20 per annum, householders could reasonably be advised by their architects to spend at least this sum on controls. Further, these savings are effected when only two radiators are in continuous use: householders who habitually use more radiators would stand to save even more by using controls.



Experimental version of BCURA controller.

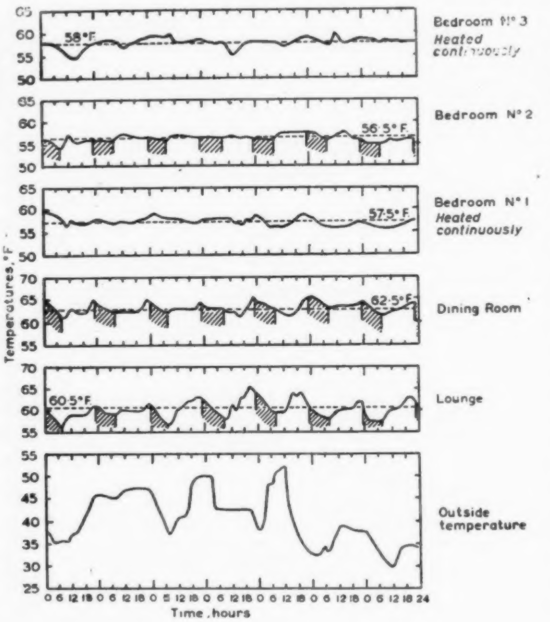


Fig. 5. Automatic regulation of by-pass valve (special tests). Shaded portions represent "off" periods of radiators. Broken lines represent average temperatures during hours of heating.

TABLE 1
ESTIMATES OF FUEL CONSUMPTIONS AND RELATIVE RUNNING COSTS WITH DIFFERENT TYPES OF CONTROL

Method of control	Average heat emission from two radiators, Btu./h.	Average emission from pipes, Btu./h.	Total average emission, Btu./h.	Seasonal fuel consumption for Ctl. htg. tons coke	Fuel* saving tons of coke, p.a.	Reduction† of fuel costs, £
No control and boiler kept at 180° F	8,000	8,000	16,000	4·5		
Reduction of boiler temperature to 150° F. at certain periods by householder	6,500	6,500	13,000	3·7		
On-off control of pump by thermostats if no room heated specially for control purposes	3,000	3,000	6,000	1·7	2·0	17
On-off control of pump by thermostats and dining-room heated 10 h. extra daily	3,750	3,000	6,750	1·9	1·8	15
Separate controllers on each radiator	2,500	8,000	10,500	3·0	0·7	6
Control of by-pass by outside temperature	3,000	3,000	6,000	1·7	2·0	17

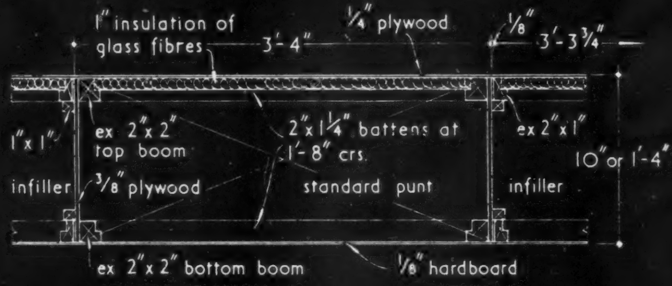
* As compared with manual reduction of boiler temperature to 150° F. by householder at certain periods.
† Price of coke taken as 169s. per ton.

ROOF STRUCTURAL ELEMENTS | TIMBER

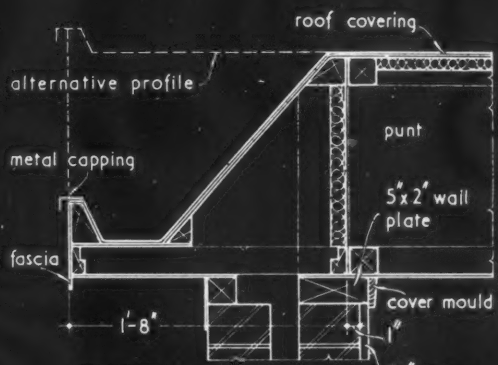
The Architects' Journal Library of Information Sheets 573. Editor: Cotterell Butler, A.R.I.B.A.

PART SECTION AND ELEVATION OF TYPICAL PUNT.

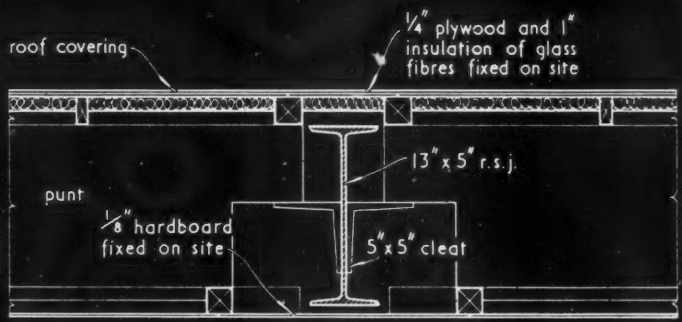
depth: 10" (maximum span 16'-8")
depth: 1'-4" (maximum span 23'-4")



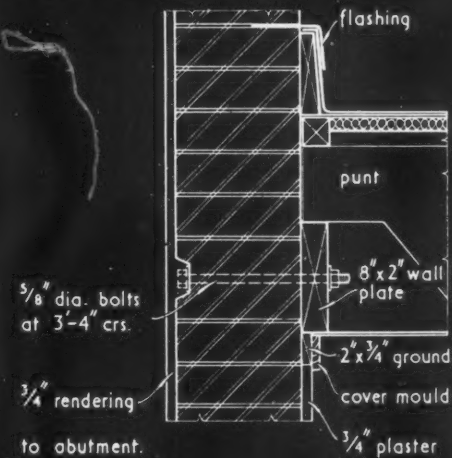
CROSS SECTION THRO' TYPICAL PUNT SHOWING INFILLERS.



over cavity wall.

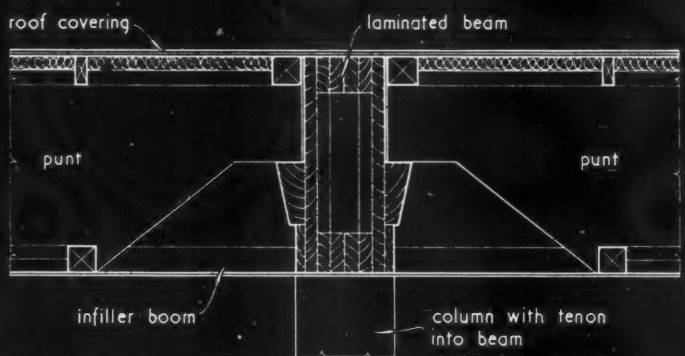


FIXING TO STEEL BEAM.

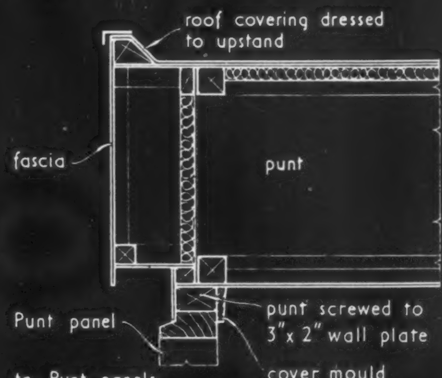


to abutment.

FIXING TO BRICKWORK.



to laminated beams and columns.



to Punt panels.

FIXING TO COMPONENTS OF PUNT SYSTEM.

PUNT SYSTEM 1 : ROOFS. Manufacturer : C.D. Productions Ltd.

20.E2 ·PUNT· SYSTEM 1: ROOFS

This Sheet describes Punt prefabricated units for constructing flat or pitched roofs for single- or multi-storeyed buildings. The complete Punt system of construction is described on Sheet 11.E1.

Design and Construction

The units or " punts " are designed on a module, usually 3 ft. 4 in., as shown in the drawings on the upper face of the Sheet. Each unit is a lightweight plywood box, with a hardboard soffit, and is shaped at the ends to incorporate beam supports.

The units are spaced at 6 ft. 8 in. centres and the 3 ft. 4 in. gap between them is spanned by infillers as shown. Standard beam components are concealed within the thickness of the roof. The roof is assembled with standard eaves and fascia units and covered with roofing felt dressed to an upstand at all edges. Sumps to rainwater downpipes may be pre-assembled in the punts where required.

Insulation: This is provided by a 1-in. glass-fibre quilt fixed inside the roof, at the top or bottom.

Sizes

Standard punts are 10 in. deep for a maximum span of 16 ft. 8 in. and 1 ft. 4 in. deep for a maximum span of 23 ft. 4 in. They are made to modular lengths.

Fixing

Owing to their extremely light weight, the roof units are very quick and easy to erect. In addition to their use with the prefabricated timber beams, columns and wall panels of the complete system, the punts can be used with traditional forms of construction and typical details of the fixings are shown on the lower face of the Sheet.

Brickwork: A wall plate, firmly held down by straps or nailing to the brickwork or blockwork over all walls, provides a base on which to support the Punt roof. The distance from the module line to the brickwork face can be varied according to each particular circumstance. The cornice moulding is fixed to the wall plates covering the fixings. Where punts are joined to an existing building, a timber beam is bolted through the wall at 3 ft. 4 in. centres. The hardboard squares and cornice moulding are fixed underneath on the site.

Steelwork: The size of steelwork usually varies considerably according to each particular span and loading, but the typical details show angle cleats which support the four corners of each punt so that the steelwork may be concealed within the depth of the punts. The hardboard squares underneath the steel are fixed on the site after the punts have been erected.

Application

The Punt roof can be used in building wherever a timber roof can be used. In addition to the advantage of a long span the Punt system provides a complete roofing service with finished ceiling underneath and gutters and waterproofing above. The roof may be applied, either flat or at a pitch, to one-storey or multi-storey buildings.

Thermal Transmittance

The thermal transmittance (U) value for the complete roof is 0·23 B.t.u./ft.^{2} hr. deg. F.

Further Information

The manufacturer maintains a technical advisory department available to answer questions dealing with the subject generally. The technical design consultants are Ove Arup and Partners, Consulting Engineers.

Other Manufacturers

The Punt system is also manufactured under licence by:

Duncan Tucker (Tottenham) Ltd.
Address: 8, Lawrence Road, South Tottenham, London, N. 15
Telephone: Stamford Hill 1212

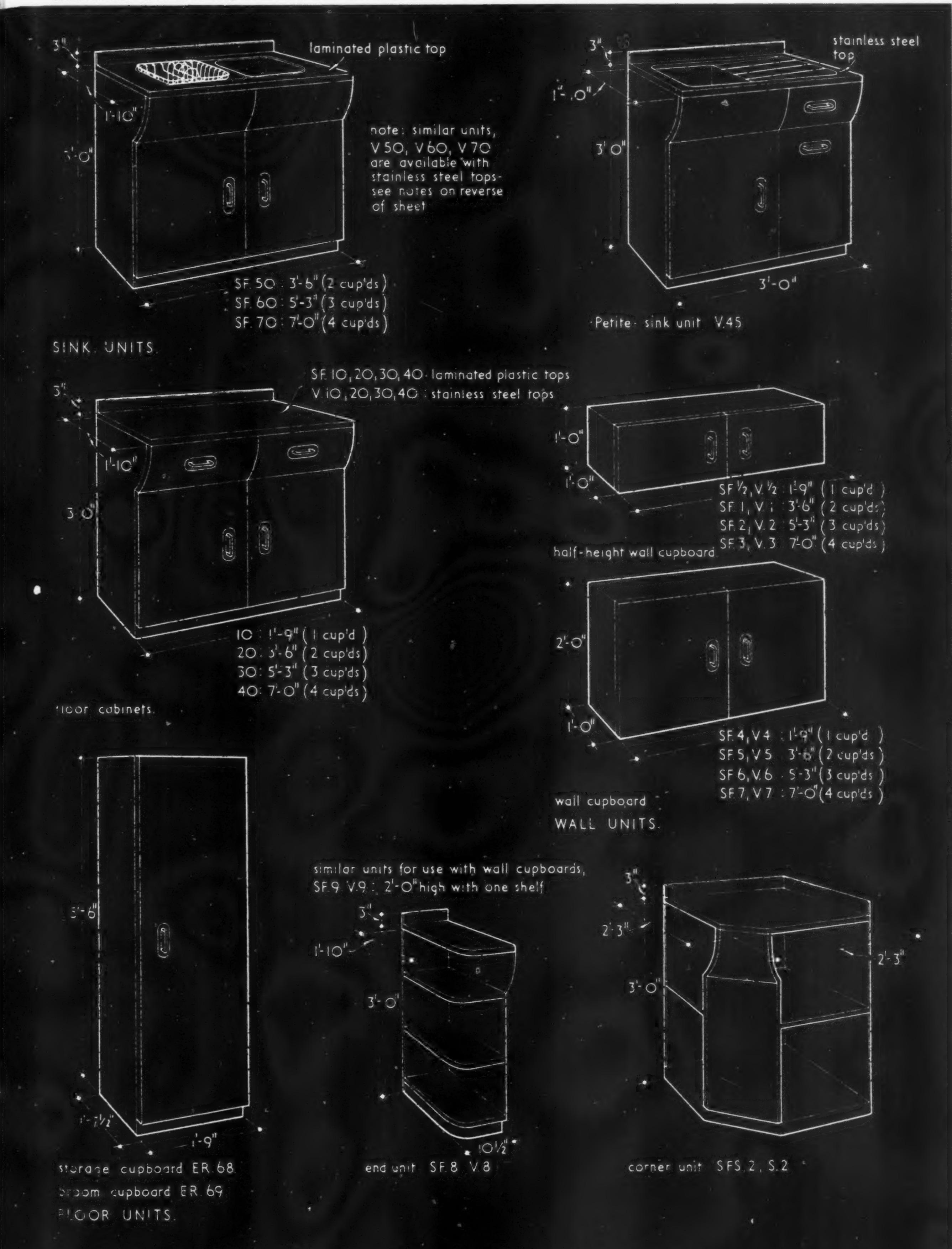
Compiled from information supplied by:

C.D. Productions Limited.
Address: 30, Uxbridge Road, London, W.12.
Telephone: Shepherds Bush 1281.

SPECIALISED FITTINGS | KITCHEN UNITS

43.E14

The Architects' Journal Library of Information Sheets 574. Editor: Cotterell Butler, A.R.I.B.A.



'ENGLISH ROSE' KITCHEN FURNISHINGS. Manufacturer: C.S.A. Industries Ltd.

43.E14 ·ENGLISH ROSE· KITCHEN FURNISHINGS

This Sheet describes English Rose kitchen furnishings: a range of appliances designed to match the furnishings is described on Sheet 43.E15: these include gas and electric cookers, refrigerators, domestic boiler and ventilating assembly.

Construction Generally

The units are constructed from pressed aluminium. Doors are sound-deadened and fitted with rubber buffers and stainless steel spring-loaded ball catches and strike-plates. Drawers run on plastic rollers and are also fitted with rubber buffers: they have an automatic stop to prevent their being pulled out completely.

Hinges: These are of pressed steel.

Handles: These are in moulded plastic with stainless steel insets.

Sizes

The sizes of the units are as given on the face of the Sheet. Sinks are 20 in. by 15½ in. by 8 in. on the V.50, 60 and 70 units and there are two sinks 16 in. by 14 in. by 7 in. on the SF. 50, 60 and 70 units.

Floor Units

Each 1 ft. 9 in. section of floor units is fitted with one drawer and one cupboard having one shelf in addition to the base shelf. Storage cupboards have four shelves and base shelf; broom cupboards have three half-shelves and base shelf. All floor units have a 3-in. high stainless steel plinth, recessed for toe space along all front edges. Holes are provided at the back of the unit for fixing to walls.

Work tops may be in Formica laminated plastic or stainless steel, the latter being recommended for units installed adjacent to a cooker as it will withstand contact with heated utensils.

Sink Units

Sink units are structurally similar to the floor cabinets previously described except that there is no drawer and intermediate shelf in the sink section. Two types of sink top are available as shown on the face of the Sheet; stainless steel with one sink with the conventional type of drainer (or drainers) and Formica laminated plastic with double stainless steel sink bowl, the draining compartment of which is provided with a wire basket for crockery.

The Petite sink unit V.45 is also available for use where floor space is limited. It is 3 ft. 0 in. wide and has a compartment under the drainer with refuse container and a small drawer for cutlery above. The drainer may be right- or left-handed.

All sinks are supplied with waste connection and provided with overflow, drain plug and chain. Sink bowls may be fitted with combined plug and strainer if required or prepared for garbage disposal units. Provision is made for mixing-valve or pillar taps.

Wall Cupboards

The 2 ft. 0 in. high wall cupboards have two shelves in addition to the base shelf. The 1 ft. 0 in. has the base shelf only. Fixing holes are provided at the back of all wall cupboards. One row of wall cupboards may be installed above another as required.

Corner Units

For floor cabinets: These are available as shown, the shelves being accessible from the adjacent doors.

For wall cabinets: Two brackets are available for supporting one cupboard unit across a corner. They are bolted to the adjoining cupboards.

End Units

These are available for finishing ends of ranges of floor or wall units.

Trolley

A service trolley is available if required for replacing a 1 ft. 9 in. section in two- three- or four-section floor cabinets. It has three shelves and a solid front with dummy drawer front at the top which hinges down to provide an extension to the top shelf. The trolley must not be fitted at the exposed end of a range of units or next to a cooker.

Filler Pieces

These are available from 2 in. to 1 ft. 8⅞ in. for use between the end cabinet of a range and a wall, between two cabinets or between a cabinet and an appliance. They must not be used between two appliances nor are they suitable for use at the exposed end of a range of units. When ordering, the exact size of the space to be filled should be stated: the necessary allowance for fitting will be made by the manufacturer. The filler pieces may have solid fronts or open fronts with vertical partitions for trays.

Cover Strips

Stainless steel cover strips are available for jointing the tops of adjacent units.

Finish

All aluminium components are Pyluminised and stove-enamelled. All stainless steel sinks and plinths are highly polished. Stainless steel work tops are polished.

Colours

Units are available in white, cream or sea green. Handles may be in matching or contrasting colour. Formica laminated plastic work tops may be scarlet red, amulet green, steel blue or orange peel Softglow colours.

Compiled from information supplied by:

C.S.A. Industries Ltd.

Address : Warwick England.
Telephone : Warwick 500.
Telegrams : Conscrew, Warwick.

FACTORY CLADDING: FACTORY AT HEMEL HEMPSTEAD

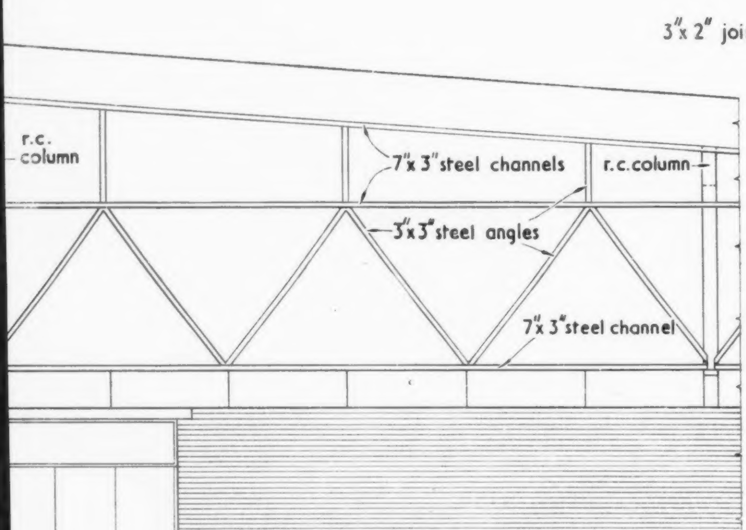
Ove Arup and Partners, designers; Philip Dowson and Francis Pym, architects-in-charge.

The steel trusses which provide the framing for the upper part of the wall are supported on brackets bolted to r.c. columns placed behind the inside face of the wall. The lower part of the wall is 9-in. brickwork built in two 4½-in. skins to give a fair face on both sides. The gap between the top of the wall and the bottom chord of the trusses is closed with a continuous strip of glazing held top and bottom in aluminium alloy sections, the 5-ft. long strips of glass being jointed with lead cames.

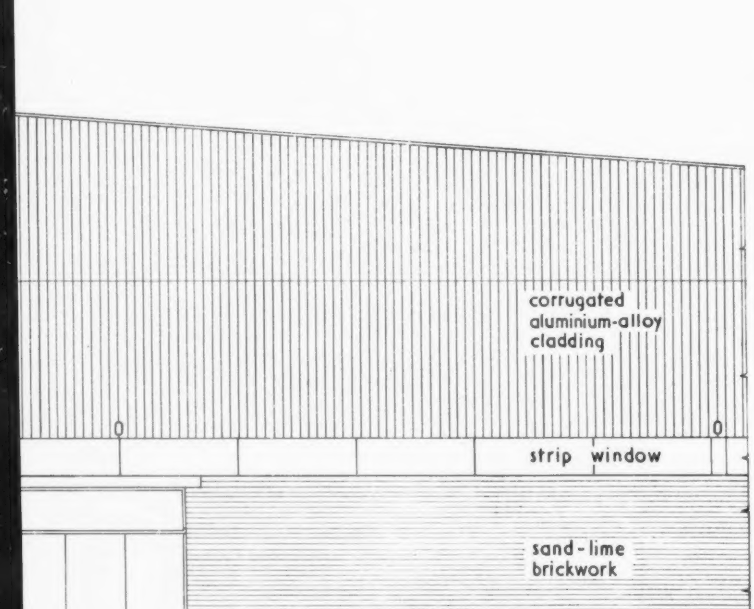
working detail

FACTORY CLADDING: FACTORY AT HEMEL HEMPSTEAD

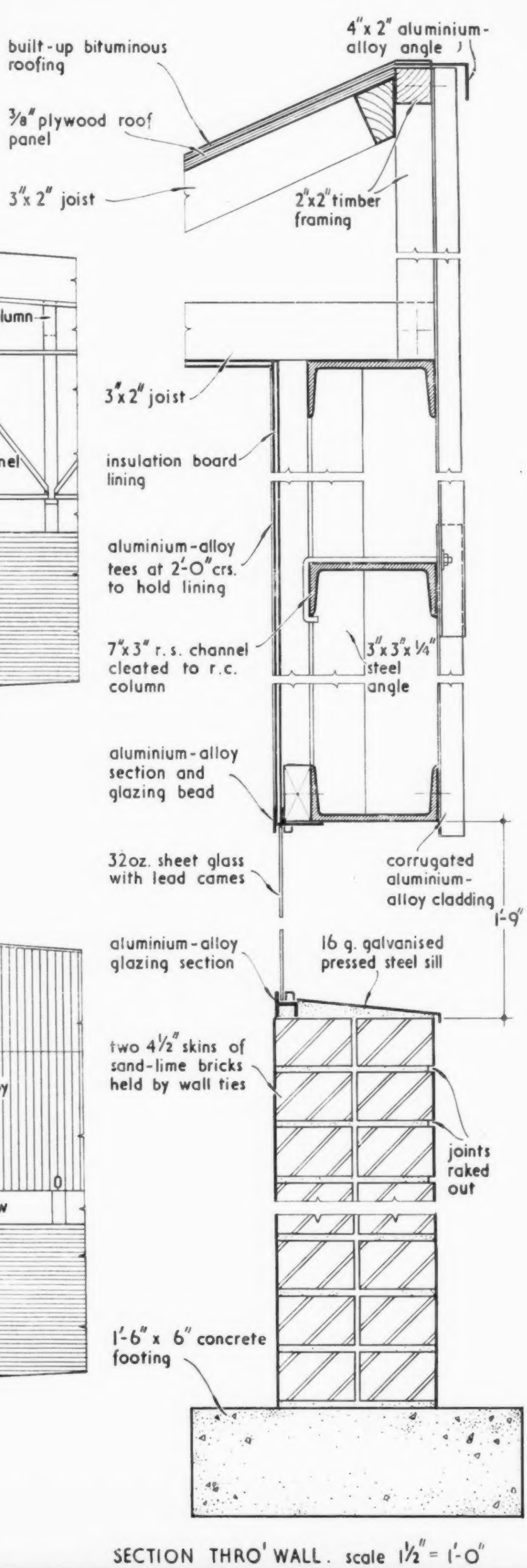
Ove Arup and Partners, designers; Philip Dowson and Francis Pym, architects-in-charge.



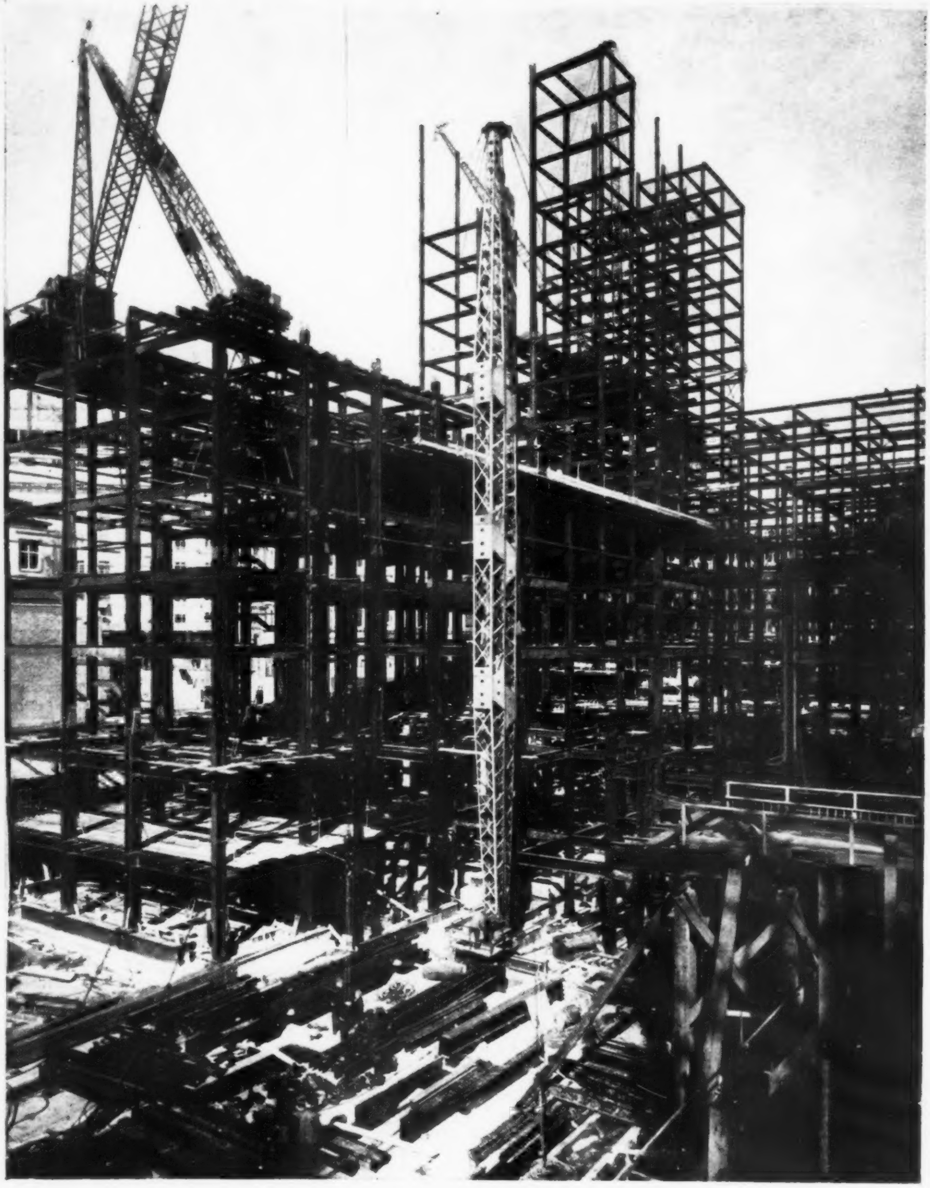
ELEVATION OF FRAMEWORK TO CLADDING.



ELEVATION. scale 1/8" = 1'-0"



SECTION THRO' WALL. scale 1½" = 1'-0"



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IDEAL HOME

Architects Invited to Design Exhibition House

The *Daily Mail* is sponsoring a competition (prizes £500, £250 and £100) for a £5,500 house (approx. 1,750 sq. ft.) to be built at the next Ideal Home Exhibition at Olympia. Arthur Kenyon and Clifford Culpin will assess the entries, together with the Exhibition organiser, L. E. W. Stokes-Roberts. Conditions can be obtained from the *Daily Mail* Architectural Competition, Gough House, Gough Square, E.C.4.

The closing date will be September 27.

RIBA

Election Results

Those elected (and not elected) to the RIBA Council for the 1956-1957 session are as follows:—

President.—Kenneth M. B. Cross, unopposed. *Past Presidents.*—C. H. Aslin and Sir Howard Robertson, unopposed.

Members of Council.—Elected: Sir Hugh Casson, 2,733 votes; Professor R. H. Matthew, 2,391 votes; F. R. S. Yorke, 2,070 votes; Professor R. J. Gardner-Medwin, 1,686 votes; J. Murray Easton, 1,599 votes; Arthur Ling, 1,562 votes.

Not elected: Hubert Bennett, Bryan Westwood, Jane Drew, Cecil Howitt, J. H. Forshaw, Frederick Pooley, Clifford Culpin, Stanley Milburn, S. E. Urwin, G. C. Saxon, W. H. Kininmonth, F. J. M. Ormrod, T. E. North, P. G. Freeman, A. Johnson, L. W. Hutson, S. Stern.

Associate Members of Council.—Elected: Stirrat A. W. Johnson-Marshall, 1,628 votes; John Stillman, 1,528 votes; Sergei Kadleigh, 1,167 votes.

Not elected: A. W. Cleeve Barr, L. Hugh Wilson, N. Percy Thomas, Richard Llewelyn Davies, D. B. Wield, A. Steele, R. Mackellar, C. H. Simmons, B. A. Le Mare, G. J. Foxley, R. T. Kennedy.

Licentiate Members of Council.—Elected: G. H. Morris (Coventry), 1,569 votes.

Not elected: Harry Durrell, W. Norman Oliver.

Announcements

PROFESSIONAL

Mr. H. Thomas, of 40, Wallingford Road, Handforth, Cheshire, will be pleased to receive trade literature on architectural acoustic products, new forms of construction, prefabricated schools, etc.

James Cubitt & Partners have opened an office at Stray Close, Slingsby Walk, Harrogate, Yorks., where Mr. J. I. H. Marshall will be pleased to receive trade catalogues etc.

E. C. Harris & Partners, Chartered Quantity Surveyors, announce their change of address from 3, Bedford Square, W.C.1. to Lynton House, 7/12, Tavistock Square, W.C.1.

V. B. Johnson & Partners, A/A.R.I.C.S., Chartered Quantity Surveyors, have moved to Leet Court, King Street, Watford, Herts. Telephone: Watford 7236/7.

The Architects & Surveyors Motor Club wish to announce that on July 8 they are organizing their all-day Surrey Treasure Hunt starting and finishing at Godstone. Details obtainable from: Barrie Meekins, 20, Balcombe Street, Dorset Square, St. Marylebone, N.W.1.

Covell & Matthews, Architects and Planning Consultants, of 34, Sackville Street, Piccadilly, W.1, have been appointed consultants to the Libyan Public Development and Stabilization Agency to advise upon perishable goods export terminal buildings and abattoirs for Tripoli and Benghazi. The building projects are estimated to cost somewhere in the region of £1,000,000, and the work is expected to be completed by mid-1958.

TRADE

Mrs. Jean L. Stewart, formerly of the ELMA Lighting Service Bureau, has recently joined the staff of Philips Lighting Design Service. Mrs. Stewart served her apprenticeship as an electrical engineer with British Thomson-Houston Company, Limited, at Rugby, and after studied at Sheffield University.

Due to expansion Midland Silicones Ltd., have moved to Union Chambers, 63, Temple Row, Birmingham, 2. Telephone: Midland 7705.

THE LIBRARY OF INFORMATION SHEETS

15.B5. *REFERENCE BACK*

Sheet 15.*B5*, *published* 14.6.56, *is a corrected version of the same Sheet published* 3.5.56 *and automatically cancels the latter.*

LAW REPORT

Frustration Plea Fails

Builders and contractors who may have relied on the decision in *Bush v. Whitehaven Port and Town Trustees* (reported in Hudson on Building Contracts, 4th edn. Vol. 2, page 122), as mitigating the risk of the effect of unanticipated future events on their tenders, will no longer be able to place any reliance thereon. This is one effect of the decision of the House of Lords in *Davis Contractors Ltd. v. Fareham UDC* (April 19, '56). In *Bush's case*, a contractor had agreed in June, 1886, to build a water main for £1,355. The site was not available until October, with the result that the work had to be done in the wet winter months instead of in the dry summer. The contractor was held to be entitled to recover an extra £600 for the extra cost of his work.

The contractors in *Davis Contractors Ltd. v. Fareham UDC* had made their tender in the expectation that they would be able to do the work in 8 months' time, and they could be regarded as having made the contract on the basis or footing that *their expectations would be fulfilled*. Equally the council had contracted on the same basis or footing and with similar expectations as to the completion of the work.

But the House of Lords pointed out that it by no means followed that disappointed expectations led to frustrated contracts. The facts in *Davis Contractors Ltd. v. Fareham UDC* were briefly these. The contractors had in 1946 entered into an agreement with the Council to build 78 houses for £94,429, the work to be completed within 8 months. Owing to various causes, including bad weather, and principally an unforeseen shortage of labour, the work took 22 months to complete. The contractors contended that by reason of the delay they were entitled to treat the contract as void, and to be paid on the basis of a *quantum meruit*, *i.e.* for the reasonable cost of the work.

The claim went to arbitration. The material findings of the arbitrator were that the contract had been entered into on the basis that *adequate supplies of labour and materials would be available* and that as they were not the basis of the contract had become so altered that the contract was to be regarded as having become frustrated and void.

The House of Lords did not agree.

The question was whether the delays were so fundamental as to alter the job which had been undertaken by the contractors into a job of a *different kind*, which was not contemplated by the contract. The job in this case never altered; it was still of the same *kind*, *i.e.* to build 78 houses of the particular size and design. It is true that it became *onerous*, but it was still the same.

What the contractors were in fact saying was: "This was originally meant to be an 8 months' job. Therefore the original contract had become frustrated and void." But that, in the view of the House of Lords, was not frustration. It was still a job to build 78 houses of a particular size and design, and the intrinsic nature and quality of the job to be done remained the same.

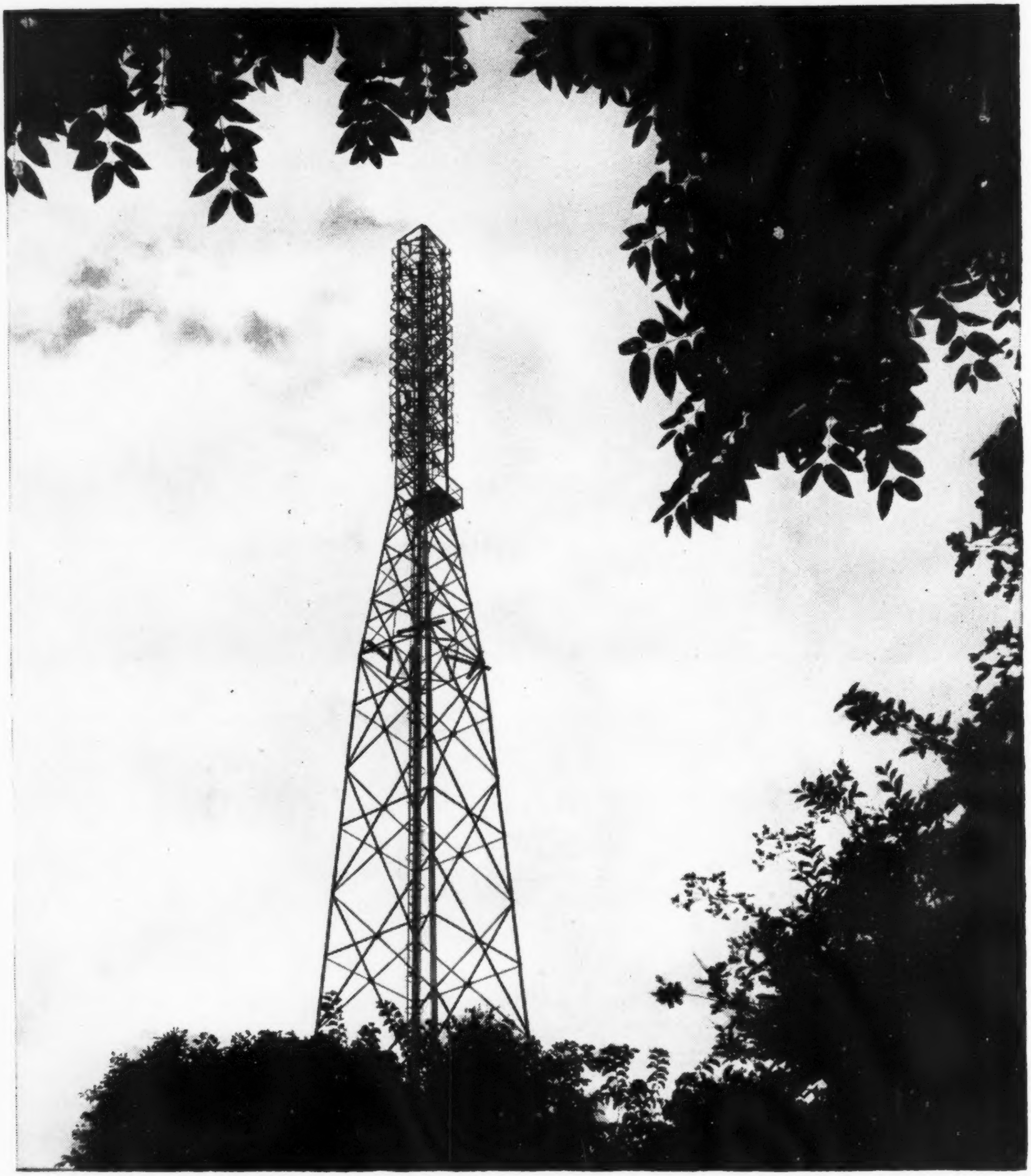
Thus, for instance, it might have been otherwise had the contractors found themselves saddled as the result of new regulations and orders to use only materials of a different and more expensive kind which would make the houses when built essentially different in character from the type of house that they had contracted to build.

As the House pointed out, even if the true basis of the doctrine of frustration was that an *implied term* was to be read into the contract to the effect that the contract was to be at an end if some specified event happened (such as, for instance, delay caused by bad weather, or shortage of labour), such a term could not be read into the contract before the Court, since the parties would never have agreed as to the inclusion of any such clause in the contract. It was not enough to say that in the event of anything unexpected happening such a term must be read into the contract; it was necessary that the contract in question should be clear as to the kind of unexpected events, on the happening of which the contract was to be at an end. Again, if the doctrine of frustration was to be regarded as resting, not on a term to be implied in the contract, but on the impact of the law itself on a situation in which an unexpected event would make it unjust to hold the parties to their bargain, the doctrine was to be kept within very narrow limits. At what time, the House inquired, in the course of this 22-month contract, did that unexpected disruptive event happen, so as to put an end to it? The events indicated that it never happened; for in effect at no time while the work was being carried on during the 22 months did the contractors say "We cannot carry on any longer; the shortage of labour and the weather has put an end to this contract. If you want us to go on, it must be on a new basis."

The plea of frustration accordingly failed in this case. The doctrine itself is of a complex character, and its true nature can best be appreciated by instances, such as the present, where its application or non-application has had to be considered.

Correction

Ashford, Trower & Walker, quantity surveyors, were omitted from the list of firms associated with the South Pier - Pavilion, Lowestoft, in our issue for May 31.



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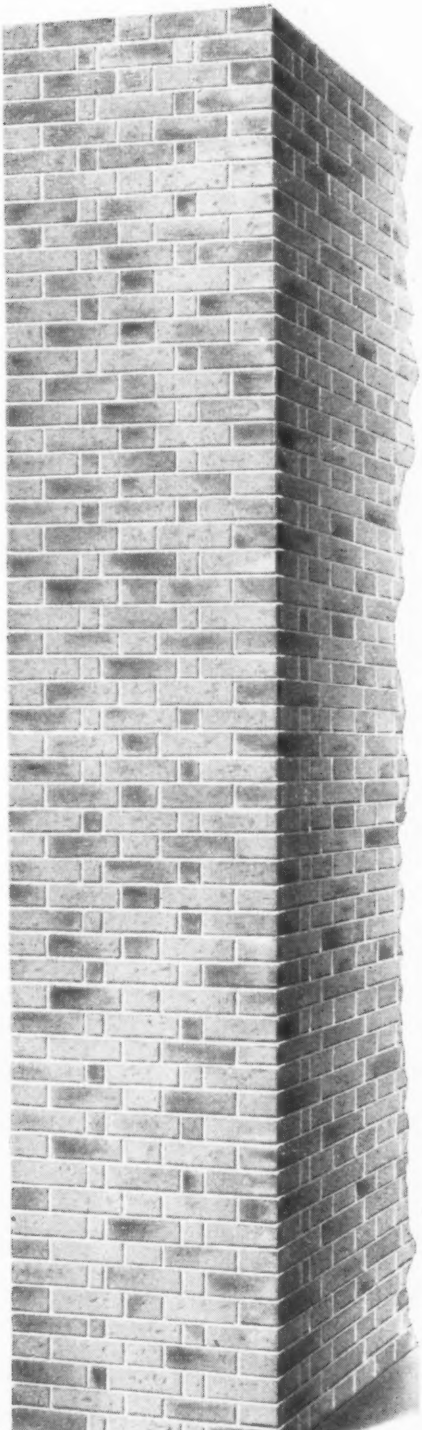

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Architect: A. W. Cleeve Barr, A.R.I.B.A.

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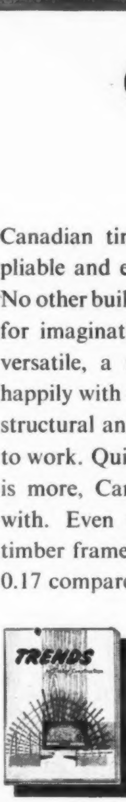
HEAL HOUSE
Hayes Common · Kent
Architect:
D. R. Hickman, A.R.I.B.A.



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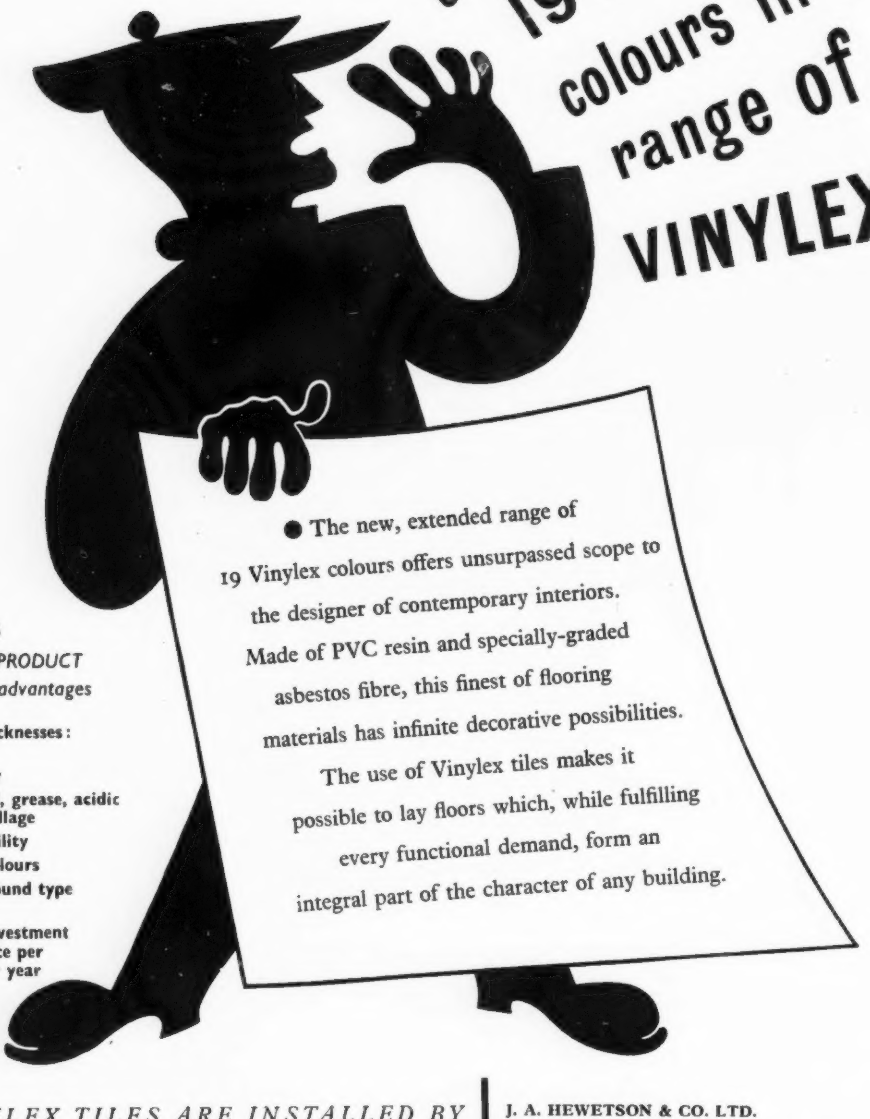

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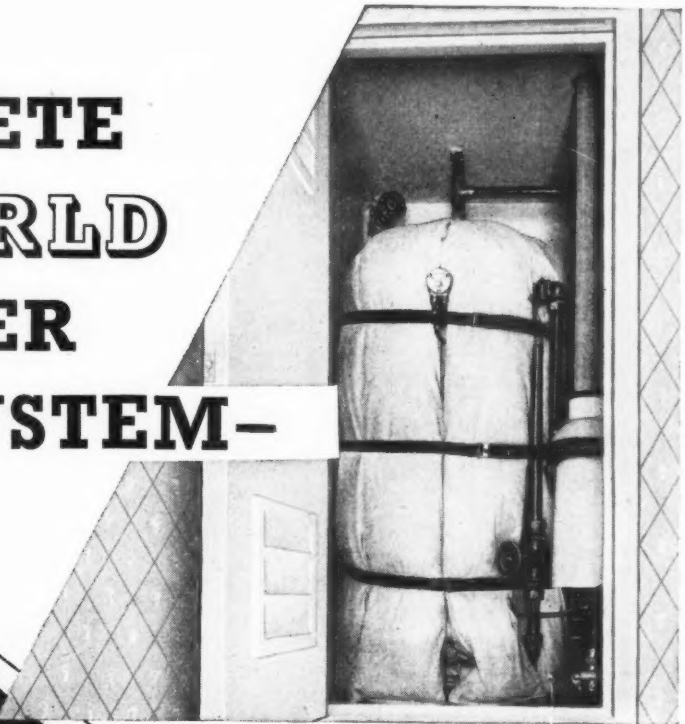
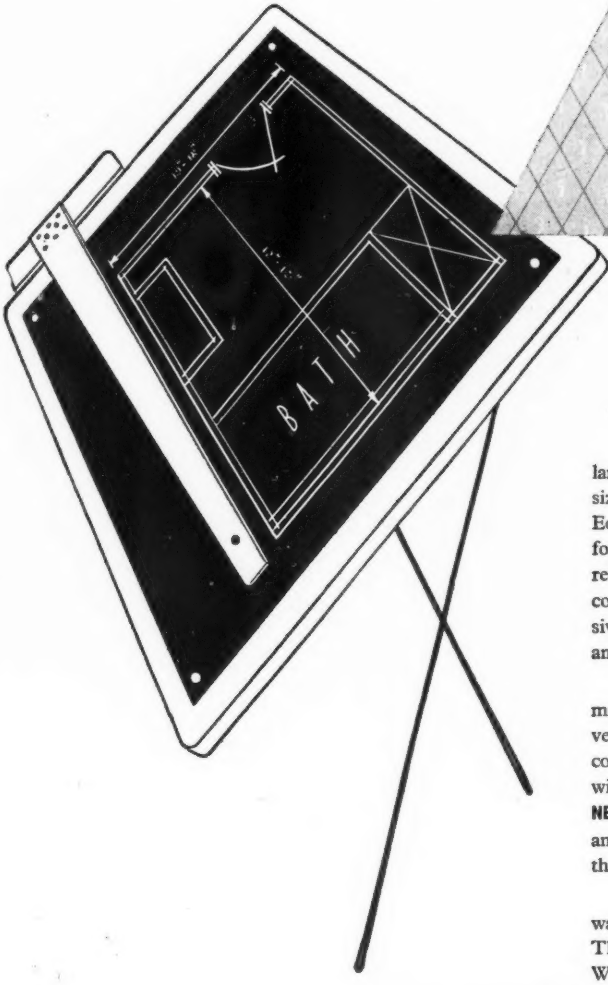
6/SE/511

A COMPLETE NEW WORLD HOT WATER SUPPLY SYSTEM–





The universal demand for a complete hot water service which is reasonably priced, easily fitted and economical to use, has turned the attention of Architects and Municipal Authorities to the NEW WORLD Gas Storage Systems.

As an example, the **NEW WORLD** C.12.S. or the larger C.28 Circulator, fitted to a lagged cylinder of suitable size, is available for use in an airing cupboard. With the Economy Valve the user has the choice of heating 4 gallons for the sink and wash basin or 20 gallons when a bath is required. The temperature of the water is automatically controlled by the Regulo. This installation is being extensively used in new houses and flats, and for the modernising and conversion of old property.

A similar type of installation is available for accommodation under the draining board in the kitchen, where if ventilation is adequate no flue is needed. When the house contains no ball valve cistern, a combination unit complete with cistern mounted on the cylinder can be supplied. The **NEW WORLD** Circulator can also be used as an auxiliary to an existing solid fuel system and is available in three sizes, the largest of which is suitable for schools and institutions.

NEW WORLD Storage Water Heaters provide hot water at the same temperature, Summer and Winter alike. They can normally be operated on the existing Gas and Water Services and require a minimum of maintenance.

recommend **NEW WORLD** PRODUCT OF Radiation Ltd ***gas storage water heaters***

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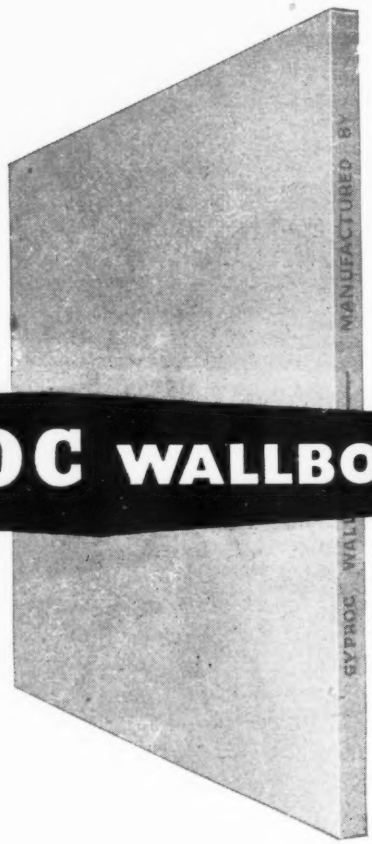
GYPROC have a name for a fire-protective wallboard with a history of successful applications



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GYPROC Wallboard is a gypsum plaster-board manufactured to B.S. 1230. It possesses Class I surfaces conforming to B.S. 476—"Surfaces of very low flame spread" and has an incombustible gypsum core. Light in weight and easily fixed, GYPROC wallboard provides an excellent base for direct decoration in all types of building. The standard sizes are 6 ft. up to 12 ft. long, 3 ft. and 4 ft. wide and $\frac{3}{8}$ in. and $\frac{1}{2}$ in. thick with square and tapered edges.

It would be well worth your while to have further information about the advantages and the potentialities of GYPROC Wallboard.
Write for leaflet AP. 359

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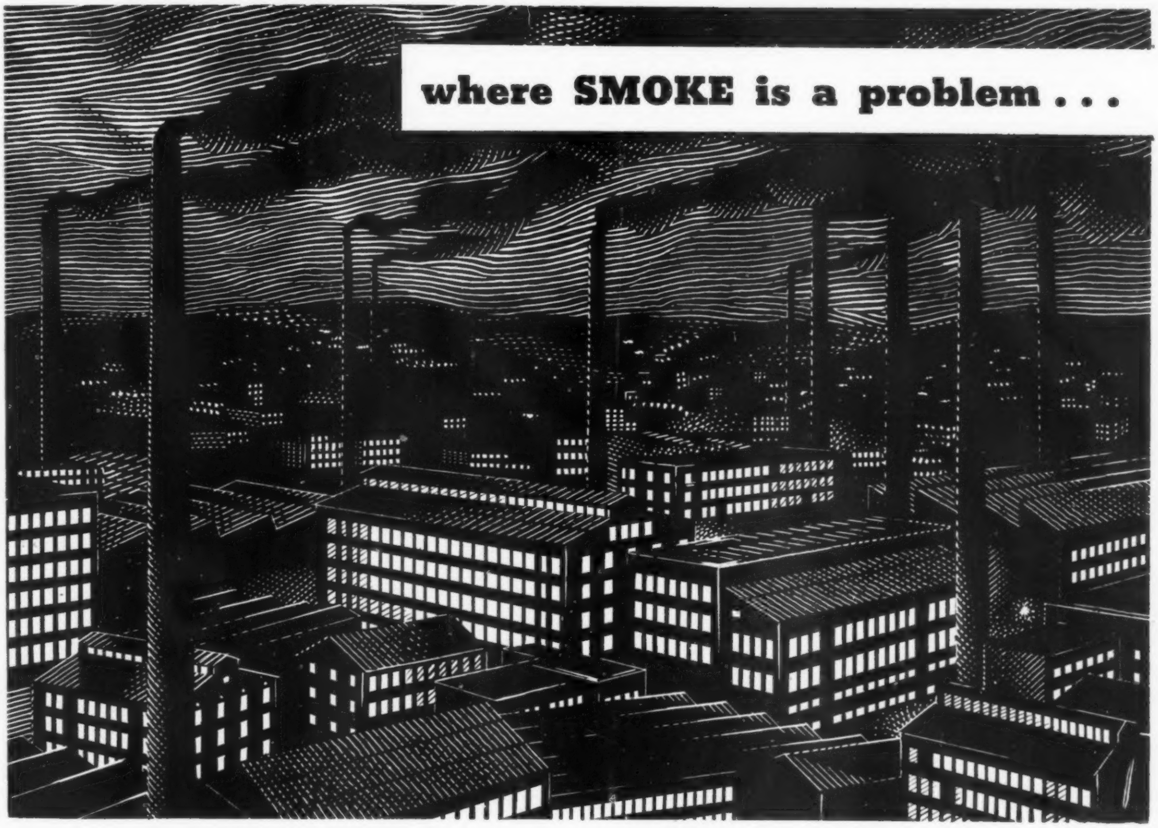

the trend is to Fuel Oil

A danger to health, a drag on production, a smudge on the landscape — smoke is all this . . . an outward sign of inefficiency. It has its counterpart in the grit which hangs in the atmosphere inside a building, often ruining products, wasting labour and increasing costs.

Progressive organisations are overcoming these problems by conversion to oil firing, thus virtually eliminating smoke, grit emission and ash. This clean and modern form of heat energy ensures maximum burning efficiency with accurate control. Moreover, it effects economies in handling, stoking and ash disposal.

Esso Fuel Oil — delivered to your premises from distribution points throughout the country — may well be the answer to *your* problem. Esso provide a country-wide technical advisory service.

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FOR ALL HEATING APPLICATIONS

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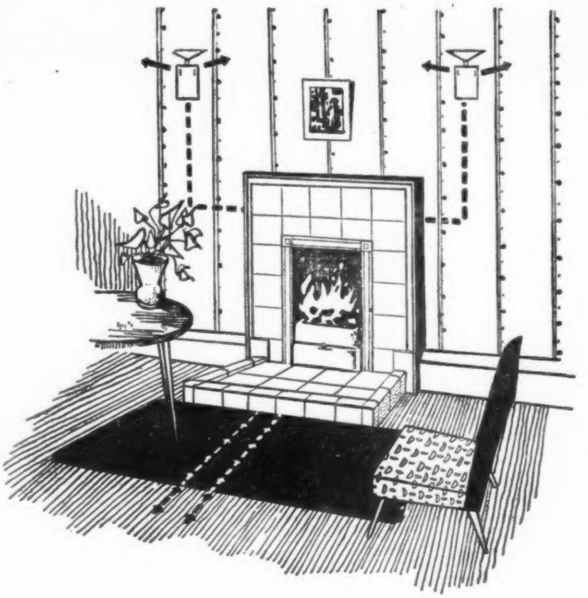

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... a genuine, high-grade, cloth-backed veneer; which will not warp, crack, shrink or expand; which can be applied direct—on flat or rounded surfaces; and which is available in a wide range of woods specially chosen for their versatility and beauty in use.

Flexwood is a superb material for interior decor, yet very reasonable in price. We shall be pleased to quote you for a complete installation on receipt of drawings.

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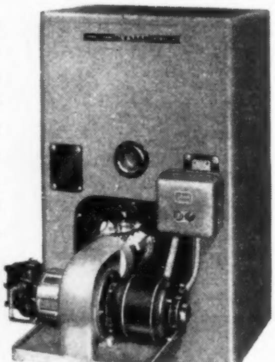

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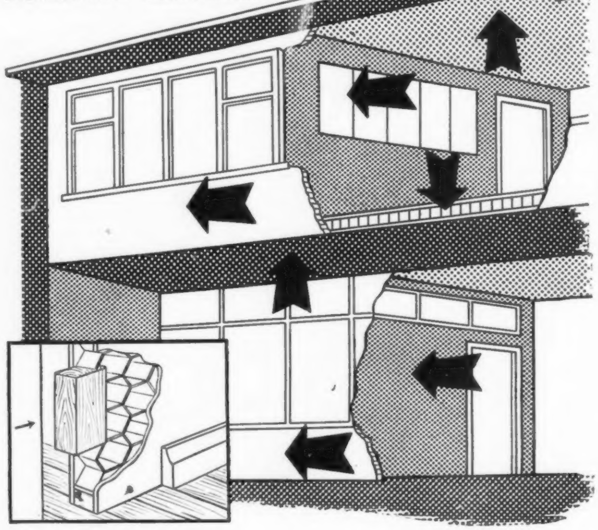
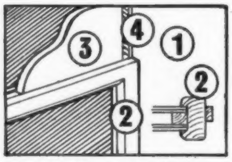
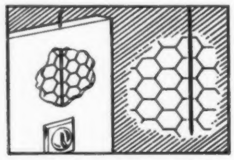


Joining the panels: blocks incorporated in each panel fit exactly. No glueing or nailing.



Door casings can be fitted anywhere in the panel. (1) Panel. (2) Door casing (also shown in section). (3) Panel above door. (4) Long stile casing cut back above door head to receive plaster board.



Piercing for wiring: a bullet-pointed rod is pushed through the panel core at required positions.

Shearwater panels go up fast, go up dry and go up anywhere! Their "Dufaylite" honeycomb core is rigidly bonded to the facing boards creating a remarkably strong, yet light, unit. There's a Shearwater panel for every purpose indoors or out; internal house, factory and office partitions, curtain walling, floor and roof decking, etc. These light, tough panels can be fixed in any position and are available in plasterboard ready for painting, plastering, etc. or in hardboard, laconite, panelwood, asbestos, formica, plywood, etc.—plain, figured, embossed, glazed or soundproofed as required.

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What it is: PLASTAWELD is a non-toxic fluid used straight from the can. Does *NOT* require stippling or blinding with sand.

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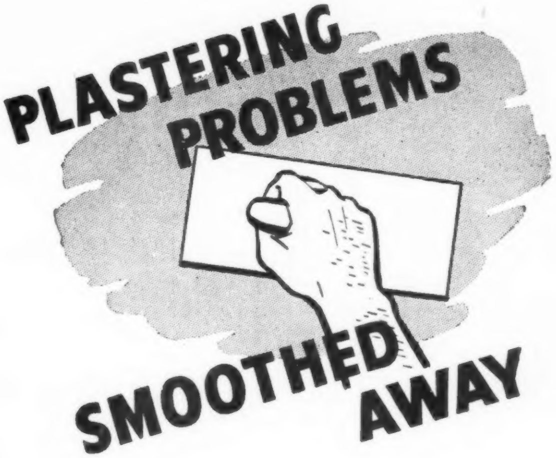

Introduced many years ago, 'Sirapite' Plaster rapidly established itself as a first-class product. Consistently developed and improved, it is now generally recognised as the ideal finishing plaster.

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The quick-setting undercoat plaster.
Specially produced to enable surfaces to be rendered and set in one day. High covering capacity.
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For use as a single coat on plaster board, fibre and other wallboards.

Full technical service available, including consultation on site. SPECIFICATION BOOKLET free on request.

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WITH "JUPITER" METAL ANGLE BEAD

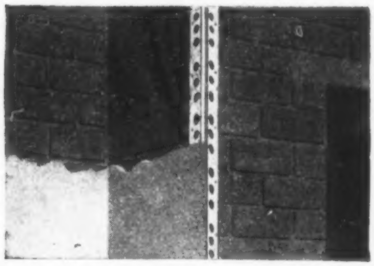
"Jupiter" Metal Angle Bead reinforces external corners of plaster work speedily, economically and permanently. Firmly embedded in the plaster, the Angle Bead, stoutly galvanised, cannot corrode. Many users merely press the bead into the rendercoat and plumb for vertical, thus eliminating even the need for nailing. There is no joint between the corner and the main face of the plaster work, and the resulting arris will neither crack nor chip. "Jupiter" has been specified for innumerable housing and other building schemes for over thirty years.

No necessity to plug the brickwork with "Jupiter". Simply nail the angle bead flanges at about 24 in. intervals between the courses.

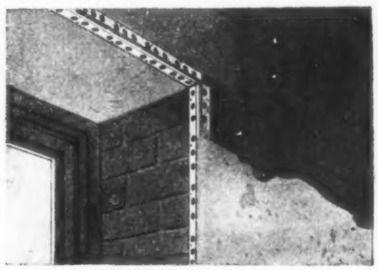
Advantages

Of using 'Jupiter' Metal Angle Bead are :—

1. Corners are proof against accidental damage.
2. No shrinkage as when using wood.
3. Most easily fixed.
4. Cheaper than Parian Angle.



Protection of a chimney breast.



Protection of a window reveal.

Descriptive leaflet and specimen section will be sent on request.

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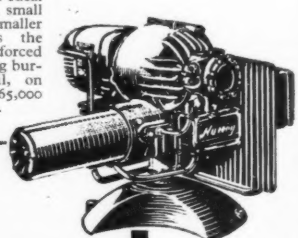
...so many fine modern homes are oil-fired by Nu-way

The modern home of Leslie Dainty, Esq., Stonnall Road, Aldridge, Staffs., heated by Nu-way.
Architect: E. H. Hickton, A.R.I.B.A.

It is natural that architects should turn to oil when heating modern buildings. Oil *is* the modern fuel—clean, labour-saving, easily stored and of reliable quality. It is just as natural that when thinking oil, designers should think Nu-way. After all, Nu-way have a long experience of oil-firing and of the problems involved. This experience is at your disposal when planning new projects.

XL. BURNER.

Fully automatic, pressure jet burner for gas oil on boilers from 60,000 to 2,000,000 B.T.U's per hour. Ideal for larger homes, small hotels, etc. For smaller homes there is the "Home-Fire" forced draught vaporizing burner for gas oil, on boilers up to 65,000 B.T.U's per hour.



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THE LEADING NAME IN OIL-FIRING

NU-WAY HEATING PLANTS LTD
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multi-layer flooring

RESINOID is a tough, durable, jointless flooring material. It has many of the qualities, and the appearance of rubber, with the added advantage of costing approximately only 10/6 (Housing Grade) or 15/6 (Heavy Duty) per sq. yard.

RESINOID

- ★ In situ (no joints); cannot warp, move or rot.
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- ★ Restfully resilient; stands drag of modern traffic.
- ★ Non-inflammable and proof against vermin.
- ★ Sound absorbing, insulating, non-conductive.
- ★ Eight attractive standard colours or to suit special requirements.
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Amongst the other floorings supplied and laid by our specialist teams are:—

DUROMIT INDUSTRIAL PAVING   CRESTALINE P.V.C. Sheet Flooring   RUBBER FLOORING   CORK TILES   LINOLEUM

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19, Queen Street, Mayfair, London, W.1.   Grosvenor 8764-5—One of The General Asphalte Group of Companies

L.1800

SPRINGFIELD PLACE, from a recent painting by Felix Kelly

Springfield Place, Chelmsford, Essex, is the home of Mr. E. R. Collister, A.A. Dipl., A.R.I.B.A. Mr. Collister recently converted much of the house into offices, and installed an oil-fired heating system. The fuel is supplied by Shell-Mex and B.P. Ltd.

THIS ARCHITECT'S HOME IS ALWAYS WARM

It has oil-fired central heating

WHEN Mr. E. R. Collister, who is an architect, decided to convert the greater part of his charming 18th century house into offices, he chose an oil-fired central heating system. Now, living and working in the same building, he enjoys an easily controlled temperature all the year round.

Mr. Collister has merely done what many people will wish to do in the next two or three years. Much of the increase in energy this country needs must come from oil-fuel if we are to maintain our post-war industrial progress. For with labour rapidly becoming our scarcest commodity, only energy in one form or another can replace it.

Moreover, the conversion to oil of central-heating plants at present using coke is doubly welcome, for it releases the coke which will be needed for the domestic grates in smokeless zones.

But one does not have to convert to oil from purely altruistic motives —there are solid advantages to be gained. Not only is oil-fired central heating economical to run, but it is also simplicity itself to operate. Only a few minutes' maintenance is needed every few weeks. There is no stoking to be done and no ash to be cleared out. Oil-fuel burns cleanly, is easily stored in large quantities, and presents no supply problems.

If you are interested in central heating for your own house, or if you are responsible for the installation or conversion of heating systems in any other premises, you may find it well worth your while to make provision for oil-firing for the heating and hot-water boilers.

In public buildings like factories, offices or schools, as well as in private houses, oil-fired central heating is the most efficient, flexible and labour-saving system there is.

If you would like any further technical information, do not hesitate to write to Shell-Mex and B.P. Ltd., Fuel Oil Dept. 2F, Shell-Mex House, Strand, London, W.C.2. This will, of course, place you under no obligation.

CLASSIFIED ADVERTISEMENTS

Advertisements should be addressed to the Advt. Manager, "The Architects' Journal," 9, 11 and 13, Queen Anne's Gate, Westminster, S.W.1, and should reach there by first post on Friday morning for inclusion in the following Thursday's paper.

Replies to Box Numbers should be addressed care of "The Architects' Journal," at the address given above.

Public and Official Announcements

25s. per inch; each additional line, 2s.

HAYES AND HARLINGTON URBAN DISTRICT COUNCIL

Applications are invited for:—

(*a*) ARCHITECTURAL ASSISTANTS (PERMANENT) (two vacancies) within Grade A.P.T. II, *i.e.*, £595—£675 per annum. (*b*) SENIOR ARCHITECTURAL ASSISTANT (TEMPORARY) within Grade A.P.T. IV, *i.e.*, £710—£885 per annum, plus London weighting, in each instance, 21—25 years £20 per annum, 26 years and over £30 per annum. Candidates for (*a*) must have passed the R.I.B.A. Inter. Exam., good experience of housing work with local authority. Housing accommodation will be made available for one of these two appointments if necessary. (*b*) Must be a Registered Architect, have good general experience in design and construction in relation to municipal housing and other works, and capable of supervising large building contracts. Housing accommodation will be made available if necessary. 5-day week. Further particulars and form of application obtainable from the undersigned, which, when completed, must be returned as soon as possible.

GEORGE HOOPER,
Clerk and Solicitor.

Town Hall, Hayes, Middlesex. 1277

CITY OF WAKEFIELD
CITY ENGINEER'S DEPARTMENT
APPOINTMENT OF PRINCIPAL QUANTITY SURVEYOR

Applications are invited for the above superannuable post on Grade A.P.T. V (£795×£35—£970).

Candidates must be Members by examination of the R.I.C.S. or the I.Q.S., and have had a wide experience in large scale Local Authority Housing, Schools, and other Municipal projects. HOUSING ACCOMMODATION WILL BE PROVIDED IF NECESSARY.

Applications, stating age, qualifications and experience, together with the names of two referees, should be received by the City Engineer, Town Hall, Wakefield, not later than 9th July, 1956. 1402

AIR MINISTRY, Works Designs Branch, requires in London and Provinces ARCHITECTURAL ASSISTANTS experienced in planning/preparation of working drawings and details for permanent and semi-permanent buildings.

Salaries up to £898 p.a. (men) and £788 (women). Starting pay dependent on age, quals. and experience.

Paid overtime. Long term possibilities with promotion and pensionable prospects, 4 weeks' leave a year. Liability for overseas service. Normally natural born British subjects. Write stating age, quals., employment details, inc. type of work done, to any employment exchange, quoting Order No., Borough 1000. 9607

LONDON COUNTY COUNCIL
QUALIFYING EXAMINATION FOR THE OFFICE OF DISTRICT SURVEYOR

An examination for certificates of proficiency to perform the duties of District Surveyor will be conducted in London in the week commencing 15th October, 1956. The minimum age limit for candidates is 25.

Possession of this certificate is necessary for appointment to positions as District Surveyor (Salary scales £1,500 to £2,900 a year) or as Assistant District Surveyor (Salary scale £1,184 to £1,353 + allowance of £56 a year).

Subsequent examinations will be held annually. Apply to The Architect to the Council (AR/ED/CTB), County Hall, Westminster Bridge, S.E.1, for application forms and further particulars. (690) 9668

COUNTY BOROUGH OF DERBY
BOROUGH ARCHITECT'S DEPARTMENT

ARCHITECTURAL STAFF:

(*a*) A.P.T. Grade V. (£795—£970 per annum)
(*b*) A.P.T. Grade IV. (£710—£885 per annum)
(*c*) A.P.T. Grade III. (£640—£765 per annum)
(*d*) A.P.T. Grade II. (£595—£675 per annum)
(*e*) A.P.T. Grade I. (£530—£610 per annum)
(*f*) Higher General Division. (£180—£500 per annum)

QUANTITY SURVEYING STAFF:

(*a*) A.P.T. Grade V. (£795—£970 per annum)

Commencing salary will be according to qualifications and experience.

Permanent superannuable appointments subject to one month's notice and to medical examination.

National Conditions of Service.

Applicants must state for which post they are applying.

Further particulars and application forms obtainable from and to be returned to The Borough Architect, The Council House, Corporation Street, Derby, not later than Monday, 9th July, 1956.

G. H. EMLYN JONES,
Town Clerk.

14th June, 1956. 1448

GOVERNMENT OF QATAR—PERSIAN GULF
STATE ENGINEER'S OFFICE

Applications are invited for the following posts under the direction of the State Engineer, Government of Qatar, Doha:—

DESIGN ENGINEER:

Applicants for the post of Design Engineer should be qualified Civil Engineers (Associate Members of the Institution of Civil Engineers or other internationally recognized body) having particular experience of the layout and design of roads (bitumen macadam and reinforced concrete) and reinforced concrete structure, together with a sound working knowledge of the design of water supply, sewerage and sewage disposal schemes. Applicants should be rapid and competent draughtsmen.

The successful applicant will assist in the design of many of the Civil Engineering works associated with a rapidly expanding town.

ASSISTANT ARCHITECT:

Applicants for the post of Assistant Architect should be qualified Architects (Associates of Royal Institute of British Architects or other internationally recognized body) having good general experience of the design of private and public buildings. Applicants should be rapid and competent draughtsmen.

The successful applicant will assist the Government Architect in the design of the many architectural projects associated with a rapidly expanding town.

Salary: For both above appointments will be according to Scale E2. Each starting at Rs. 1,775 an Arabic month with annual increments of Rs. 75 a month up to Rs. 2,000, and then by annual increments of Rs. 100 per month to a maximum of Rs. 2,300 per month. (Rs. 1,775 an Arabic month is equivalent to £1,590 Sterling a Gregorian year.)

Gratuity: Payable on the basis of one month's pay for each completed year of service, on completion of contract only.

Probation: Probationary period of six months during which contract may be terminated at three months' notice by the Government, without stating its reason.

Contract: A five-year contract subject to successful completion of the probationary period. The employee may terminate the contract at three months' notice only after completing one year's service.

Accommodation: Free furnished bachelor accommodation, fuel, light and water. Married accommodation will be provided in accordance with the rules but in no case before successful completion of probationary period.

Leave: Will be earned at the rate of 6 days for each completed month of duty.

Free Travel: On first journey to Qatar, leave not exceeding one return 1st class Air passage in each year and termination for applicant, wife and children up to 18 years of age.

General: The climate is hot for about five months of the year but this is offset by air-conditioning in staff houses and offices. Good climate for the rest of the year.

No income tax. Duty car allowance. Free medical and dental treatment.

Applications endorsed "Design Engineer" or "Assistant Architect" as the case may be, giving full personal particulars, including age, nationality, religion, education, marital status, qualifications, training, past experience and employment, names and addresses of three referees and latest photograph should be sent in duplicate to:

The Adviser to the Government of Qatar,
P.O. Box No. 36,
Doha, Qatar,
Persian Gulf.

A further copy with enclosures similarly endorsed should be sent to:

Messrs. C. Tennant, Sons & Co. Ltd.,
4, Copthall Avenue,
London, E.C.2. 1451

CITY OF CAMBRIDGE

Applications are invited for the following appointment in the Architects' Section of the City Surveyor's Department.

ASSISTANT ARCHITECT. (Grade III. Salary: £640—£765, entry point in accordance with experience.)

Applicants should be A.R.I.B.A. or at Final stage, and must have had good office experience of Housing and if possible School projects. There is an interesting and varied programme of work in the Section.

The appointment is superannuable, subject to medical examination and terminable by one month's notice on either side.

Housing accommodation will be considered.

Forms of application may be obtained from the City Surveyor, The Guildhall, Cambridge, to whom they should be returned not later than the 7th July, 1956.

ALAN H. I. SWIFT,
Town Clerk.
1420

METROPOLITAN BOROUGH OF SHOREDITCH

Applications are invited for the appointment of TWO ASSISTANT ARCHITECTS. Salary within Grades A.P.T. III and IV (£670 to £915), according to experience and qualifications. Subject to medical examination, Council's superannuation scheme, and N.J.C. conditions.

Applications to Borough Architect, Town Hall, Old Street, E.C.1, stating age, training and experience, giving names of two referees, to arrive by 7th July, 1956. 1401

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of LECTURER IN TOWN AND COUNTRY PLANNING. Applicants must be qualified Architects and Corporate Members of the Town Planning Institute. Salary on a scale rising to £1,350 per annum, with membership of the F.S.S.U. and Children's Allowance Scheme; initial salary according to qualifications and practical experience. Applications should be sent not later than 21st July to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained. 1456

COUNTY BOROUGH OF ROTHERHAM
ARCHITECTURAL ASSISTANTS

Applications are invited for the following appointments:—

(*a*) Architectural Assistants (3 vacancies) at a salary in accordance with the Special Grade, £690—£840.

(*b*) Senior Architectural Assistant at a salary in accordance with Grade A.P.T. IV, £710—£885.

Candidates for (*a*) are required to have passed Parts I and II of the R.I.B.A. final examination and (*b*) to be Associate Members of the R.I.B.A. with good general experience in design and construction.

Applications to be endorsed "Architectural Assistants" stating age, qualifications and details of experience, together with the names of two referees, should be received by me not later than Monday, the 9th July, 1956.

Canvassing will disqualify.

JOHN S. WALL,
Town Clerk.

Municipal Offices,
Rotherham. 1455

COUNTY BOROUGH OF EAST HAM
THREE ARCHITECTURAL ASSISTANTS
(APT.V)

Applications are invited for the above appointments in the Housing Department at salaries in accordance with Grade APT.V (£795×£35—£970) plus London Weighting.

The Department has an extensive and interesting programme of mixed development of houses, flats and shops, and the redevelopment of slums, including multi-storey flats.

Further details and forms of application (returnable by 11th July, 1956) from the Town Clerk, Town Hall, East Ham, E.6. 1446

LANCASHIRE COUNTY COUNCIL

Applications are invited for the following vacancies at Accrington:—

PLANNING ASSISTANT, within £690—£885, dependent on qualifications and experience. Applicants should possess a recognised qualification in architecture, surveying, engineering or town planning; planning experience desirable but not essential.

DRAUGHTSMAN/WOMAN. Salary, over 21, within £365—£510, according to ability and experience; under 21 by age scale giving £275 at 18, £330 at 20.

Applications, stating appointment applied for, giving age, qualifications, present appointment, experience, etc., and two referees, to the County Planning Officer, East Cliff County Offices, Preston, by 9th July, 1956. 1484

COUNTY BOROUGH OF PRESTON
APPOINTMENT OF ASSISTANT ARCHITECT

Applications are invited for the above appointment in the Borough Surveyor's Department. Candidates must be Registered Architects, also Corporate Members of the R.I.B.A., and have had a good general experience in the design and erection of Public and Educational Buildings together with Housing Schemes.

The salary scale is £690 to £840, the commencing salary to be fixed within the scope of this grade according to experience.

Standard form of application, obtainable with the conditions of the appointment from my Department, should be completed and returned to the undersigned not later than Monday, 9th July, 1956.

W. E. E. LOCKLEY,
Town Clerk.

Municipal Building, Preston. 1482

CITY OF PETERBOROUGH
APPOINTMENT OF ARCHITECTURAL ASSISTANT,
Grade A.P.T. II (£595×£20—£675)

Applications are invited for the above appointment in the City Engineer's Department. Applicants must be of Intermediate R.I.B.A. standard, possess a sound knowledge of building construction and be capable of preparing working and detail drawings under supervision. Previous experience on school buildings will be an advantage.

Applications, stating age, experience, details of qualifications, together with copies of three recent testimonials, should be sent in envelopes endorsed "Architectural Assistant," to Mr. L. H. Robjohn, M.B.E., A.M.I.C.E., City Engineer and Surveyor, Town Hall, Peterborough, to reach him not later than 7th July.

Consideration will be given to the provision of Council housing accommodation.

Canvassing, directly or indirectly, will disqualify. Candidates must disclose whether they are related to any member or senior officer of the Council.

C. PETER CLARKE,
Town Clerk.

Town Hall, Peterborough.
June, 1956. 1472

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

The Board are engaged on a number of new building projects, including a new hospital at Welwyn, and the following staff are required to fill new posts on the establishment created to deal with the increased work.

(a) ASSISTANT ARCHITECTS. Good experience of design and construction necessary, preferably in hospital work. Salary scale: £640 × £25 (4) × £30 (4) × £35 (2)—£930, plus £20—£40 London weighting. Improved scale expected.

(b) ARCHITECTURAL ASSISTANTS. To give technical assistance to professional officers. Salary scale: £480 (age 21 and over) × £20 (7) × £25 (2)—£670, plus £20—£30 London weighting. Improved scale expected.

Applicants for (a) above must be Associate Members of the R.I.B.A., and for (b) must have Inter. R.I.B.A. Commencing salary above minimum may be paid to successful candidates, according to appropriate experience since qualification. Posts are subject to Whitley Council conditions and are superannuable.

Apply, stating which post and giving age, qualifications (with dates) and experience, with names of two referees, to Secretary, North West Metropolitan Regional Hospital Board, 11a, Portland Place, W.1, by 16th July. 1476

HAMPSHIRE

Applications are invited for the appointment of a SENIOR PLANNING ASSISTANT in the South-East Area Office of the County Planning Department at Fareham on A.P.T. Grade IV (£710—£885).

Candidates should be graduates or have a professional qualification, and at least two years' experience in the Planning Department of a public authority. Further desirable qualifications are competency in surveying and draughtsmanship, considerable experience in layout and design of housing estates and also in general architectural work.

The appointment is pensionable and subject to a satisfactory medical report. In approved cases the County Council may assist newly appointed staff to meet removal and other expenses. Officers using their own cars when travelling on County Council duties will receive travelling expenses on the County scale for the time being in force.

Applications, stating age, education, qualifications and experience, with a copy of one testimonial and the names of two referees, should reach the County Planning Officer, Litton Lodge, Clifton Road, Winchester, by the 21st July. 1469

CITY OF BRADFORD
CITY ENGINEER AND SURVEYOR'S DEPARTMENT

Applications are invited for the following superannuable appointments on the grades indicated:—

(a) SENIOR TOWN PLANNING ASSISTANT, A.P.T. IV (£710—£885). Post No. 14.

(b) ARCHITECTURAL ASSISTANT, A.P.T. I £530—£610), or A.P.T. II (£595—£675), according to qualifications. Post No. 123.

Candidates for post (a) should have had experience in preparation of development and in the examination of planning applications in connection with current development. Must have a sound knowledge of the Town and Country Planning Acts and Regulations, and experience in preparing evidence in connection with Appeals. He should be A.M.T.P.I. and/or A.M.I.Mun.E., A.M.I.C.E., or A.R.I.B.A.

Applicants for post (b) should have had experience in the layout and design of housing estates. Candidates should have passed the Intermediate Examination of the appropriate professional body to qualify for Grade A.P.T. II.

All applicants should have completed their National Service. No housing accommodation can be provided by the Corporation.

Applications, on forms to be obtained from the City Engineer and Surveyor, Town Hall, Bradford, 1, together with three testimonials, must be received by the undersigned by 20th July, 1956.

W. H. LEATHEM,
Town Clerk.

Town Hall, Bradford, 1. 1470

ARCHITECTS AND MAINTENANCE SURVEYORS IN GOVERNMENT DEPARTMENTS

The Civil Service Commissioners invite applications for pensionable posts for about SIX ARCHITECTS and FOUR MAINTENANCE SURVEYORS.

Age at least 25 and under 35 on 1st July, 1956, with extension for regular Forces service and appropriate civil service. Candidates must be Registered Architects, or for Maintenance Surveyor posts, Corporate Members of the R.I.C.S. (Building Section), or have passed examinations necessary for obtaining Corporate Membership.

London salary scale: Men, £741 (at age 25) to £1,160. Starting salary up to £1,018 at age 34 or over on entry. Prospects of promotion. Salaries of next higher grades are £1,160—£1,500 and £1,555—£1,760. Somewhat lower in the provinces. Women's scales lower, but being increased under equal pay scheme.

Salaries and conditions of service are under review.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S.60-61/56/7. Application forms should be returned by 14th August, 1956. 1521

WARWICKSHIRE COUNTY COUNCIL
ARCHITECT'S DEPARTMENT

Applications are invited for the following appointments:—

(a) SENIOR ASSISTANT ARCHITECTS, Grade A.P.T. V (£795—£970). Applicants must be competent designers, having a knowledge of modern methods of construction, and be capable of handling large building projects from sketch plan stage to completion.

(b) ARCHITECTS, Grade A.P.T. IV (£710—£885). Applicants must be competent designers, having a good knowledge of construction and be capable of handling medium sized contracts.

(c) ASSISTANT ARCHITECTS, scale £690—£840. The successful applicants will work in teams on large projects, but opportunity will be given to men with enthusiasm and ability to design and carry out smaller projects under the Group Architect.

(d) CLERKS OF WORKS. Applicants are invited for the appointment of Clerks of Works to supervise the erection of new school buildings in various parts of the County. Salary £14 per week.

The commencing salaries can be within the grades according to the ability and experience. The appointments, except (d) are on the established staff and subject to the Scheme and Conditions of Service of the National Joint Council for Local Authorities. All appointments are subject to the Local Government Superannuation Acts, 1937—1953. Successful candidates will be required to pass a medical examination.

The Council is unable to offer successful candidates housing accommodation.

Applications are to be on forms which can be obtained from G. R. Barnsley, F.R.I.B.A., County Architect, Shire Hall, Warwick.

L. EDGAR STEPHENS,
Clerk of the Council.

Shire Hall, Warwick.
June, 1956. 1473

MINISTRY OF HOUSING AND LOCAL GOVERNMENT: HOUSING AND PLANNING INSPECTORS. The Civil Service Commissioners invite applications for twenty pensionable posts in London. Duties include the conduct of public local inquiries in any part of England and Wales into matters arising under the Housing Acts and Town and Country Planning Acts. Age at least 35 on 1st June, 1956. Qualifications—one or more of the following:—Registered Architect; Corporate membership of: Institution of Civil Engineers; Town Planning Institute; Institution of Municipal Engineers; Royal Institution of Chartered Surveyors; Chartered Auctioneers and Estate Agents' Institute; Land Agents Society. Practical experience in housing (preferably local authority housing) or in town and country planning, is necessary. Starting pay (for 45½ hour week): men, £1,253 (at age 35-37) up to £1,382 at age 40; women, £1,172 up to £1,289; exceptionally, at 40 or over higher starting pay if outstandingly well qualified. Inclusive maxima: men £1,620, women £1,478. Women's pay being improved under equal pay scheme. Promotion prospects. Salaries and conditions of service are under review.

Particulars and application form from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S4603/56/10. Application forms should be returned by 16th July, 1956. 1522

LONDON TRANSPORT EXECUTIVE
requires
ARCHITECTS, QUANTITY SURVEYORS, STRUCTURAL ENGINEERS
for
ARCHITECT'S DEPARTMENT

Salary scales:—

(a) EXECUTIVE ASSISTANTS (£940—£1,100).

(b) ARCHITECTURAL, STRUCTURAL, and QUANTITY SURVEYING ASSISTANTS (£750—£840).

(c) GENERAL TECHNICAL ASSISTANTS (£340 at age 18 to £710), plus additional payments for certain required qualifications.

Applicants for Executive Assistant grade must be fully qualified and experienced in supervising a group of Assistants.

Free travel; medical examination; alternate Saturdays off duty; 38-hour week. Applications, within 14 days, to Recruitment and Training Officer, London Transport, 55, Broadway, S.W.1, quoting vacancy number F/EV.588, (a), (b), or (c). 1517

CITY OF CARDIFF
CITY SURVEYOR'S DEPARTMENT
APPOINTMENT OF CLERK OF WORKS
(WALES EMPIRE POOL)

Applications are invited for the above appointment, to supervise the erection of the Wales Empire Pool, Wood Street, Cardiff, at a salary of £1,000 per annum.

Applicants must have extensive technical knowledge of the building trade, and experience in the construction of reinforced concrete structures for the storage of liquids will be an advantage.

Applications, giving full details of age, experience, past and present appointments, together with the names of three referees, should be delivered to the undersigned not later than the 21st July, 1956, in a plain sealed envelope endorsed "Clerk of Works, Wales Empire Pool."

S. TAPPER-JONES,
Town Clerk.

City Hall, Cardiff.
June, 1956. 1515

CENTRAL ELECTRICITY AUTHORITY
EAST MIDLANDS DIVISION

Applications are invited for the following position within the Division:—

SENIOR DRAUGHTSMAN (CIVIL), Generation (Construction) Department. Vacancy No. 133/56/AJ.

Candidates should have experience in the preparation of detail drawings and in the design of one or more of the following subjects:—

Reinforced concrete structures.

Piled and slab foundations for heavy components.

Cable subways, bridges and culverts.

Salary will be in accordance with Grade 4 (£810—£910 per annum) for Grade 5 (£700—£800 per annum) of Schedule D of the National Joint Board Agreement.

Closing date for receipt of applications: 12th July, 1956.

This appointment will be pensionable within the terms and conditions of the Central Electricity and Area Boards (Staff) Superannuation Scheme.

Applications should be submitted on the official form AE6/ACT, which may be obtained from the Divisional Establishments Officer, Central Electricity Authority, P.O. Box 25, Barker Gate, Nottingham, and returned to the undersigned. Please quote Vacancy Number.

L. F. JEFFREY,
Divisional Controller.
1508

BOROUGH OF RAWTENSTALL
APPOINTMENT OF CHIEF ARCHITECTURAL ASSISTANT

Applications are invited from suitably qualified persons for the above-mentioned appointment, at a salary at the maximum of A.P.T. Grade IV, viz., £885 per annum.

The appointment is on the Council's permanent staff and is subject to the Local Government Superannuation Acts, 1937-53, the passing of a medical examination, and to termination by one month's notice on either side.

Housing accommodation will be provided for the successful candidate, if married, and reasonable removable expenses paid.

Applications, stating age, qualifications, present and previous appointments, and giving full details of experience, together with names and addresses of two referees, should be delivered to the undersigned not later than Monday, the 16th July, 1956.

(Signed) J. W. BLOMELEY,
Town Clerk.

Town Hall, Rawtenstall, Rossendale, Lancs.
20th June, 1956. 1518

COUNTY BOROUGH OF SOUTHAMPTON
BOROUGH ARCHITECT'S DEPARTMENT

Applications are invited for the following appointments:—

(a) SENIOR ASSISTANT ARCHITECT, Grade V (£795—£970).

(b) SENIOR ASSISTANT ARCHITECT, Grade IV (£710—£885).

(c) SENIOR QUANTITY SURVEYOR, Grade IV (£710—£885).

(d) ASSISTANT QUANTITY SURVEYOR, Grade II (£595—£675).

(e) ASSISTANT QUANTITY SURVEYOR, Grade I (£530—£610).

Applicants should possess the appropriate qualifications for Special Classes of Officers under N.J.C. Conditions of Service.

Applicants should state their housing needs.

Application forms from the Borough Architect, Civic Centre, Southampton. Closing date: 18th July, 1956. 1497

CITY OF PETERBOROUGH
APPOINTMENT OF QUANTITY SURVEYOR, CITY ENGINEER'S DEPT.

Applications are invited from qualified QUANTITY SURVEYORS for the above appointment, at a salary of Grade II, A.P. & T. (£595 per annum, rising by four annual increments of £20 to a maximum of £675).

Applicants should have wide experience, including taking off bills for new schools.

Any further information can be obtained from the City Engineer and Surveyor (Mr. L. H. Robjohn, M.B.E., A.M.I.C.E.).

Consideration will be given to the provision of Council housing accommodation.

Closing date for receipt of applications: Thursday, 12th July, 1956.

C. PETER CLARKE,
Town Clerk.

Town Hall, Peterborough.
June, 1956. 1500

GLOUCESTERSHIRE EDUCATION COMMITTEE
CHELTENHAM COLLEGE OF ART
(AMENDED ADVERTISEMENT)

STUDIO INSTRUCTOR required for School of Architecture in September. "Listed" School, with full-time and part-time courses.

Salary: New Burnham Technical Scales, Grade B, as recently recommended (£650 to £1,025 per annum), plus graduate and training allowances, operative from 1st October. A fully qualified school-trained Architect would commence at a minimum salary of £764 to £1,139.

Application forms and further particulars obtainable from the Principal. Applications should be returned within 14 days of the appearance of this advertisement. 1507

DURHAM COUNTY COUNCIL
PLANNING DEPARTMENT
ASSISTANT AREA PLANNING OFFICERS. Salary £795—£970. Must be Associate Members of the Town Planning Institute, and have had at least 3 years' experience since qualifying in all aspects of development control work, and preferably some experience of Town Maps.
PLANNING ASSISTANTS, primarily for Town Map Work (2). Salary £710—£885. Must be Associate Members of the Town Planning Institute.
ARCHITECTURAL ASSISTANT. Salary £690—£840 or £710—£885, according to experience. Must be qualified by examination. Successful applicant will be engaged on housing layouts, town centre layouts, and the control of elevations.
Housing available: Peterlee, 12½ miles; Newton Aycliffe, 12 miles from Durham. Further particulars, including forms of application, which are returnable by 11th July, 1956, obtainable from the County Planning Officer, 10, Church Street, Durham.
Canvassing members of the Council is prohibited.
J. K. HOPE,
Clerk of the County Council.
1506

SURREY COUNTY COUNCIL
COUNTY PLANNING DEPARTMENT
Applications are invited for the following Headquarters appointments of Kingston-upon-Thames:—
(a) ASSISTANT COUNTY PLANNING OFFICER, Grade B (£1,097×£52—£1,307), to be responsible for work on the Development Plan and the requirements of other Services.
(b) ASSISTANT COUNTY PLANNING OFFICER, Grade B (£1,097×£52—£1,307), to be generally responsible for Development Control.
These two posts will be third in seniority at Headquarters.
Applicants should be Corporate Members of the Town Planning Institute, and applications, stating age, experience, and qualifications, together with the names of two persons to whom reference may be made, should be lodged with the Clerk of the Council not later than 16th July, 1956.
County Hall, Kingston-upon-Thames. 1501

COUNTY BOROUGH OF CARLISLE
Applications are invited for the following posts in the City Surveyor's Department:—
(a) SENIOR ASSISTANT ARCHITECT, A.P.T. IV (£710×£35—£885).
(b) SENIOR ASSISTANT QUANTITY SURVEYOR, A.P.T. IV.
(c) TWO SENIOR ASSISTANT ENGINEERS, A.P.T. IV.
(d) BUILDING SURVEYOR, A.P.T. III (£640×£25—£765).
Applicants for (a) to have passed R.I.B.A. Final Examination or equivalent at recognised School of Architecture, and to have at least 5 years' experience, including period of training. Applicants for (b) to have passed R.I.C.S. Final Examination. Applicants for (c) to be A.M.I.C.E. or A.M.I.Mun.E., or equivalent. Applicants for (d) to have R.I.C.S. (Building) or equivalent qualifications, and to be capable of handling minor building works, alterations, additions, etc. Some housing accommodation available if required.
Forms of application from City Surveyor, 18, Fisher Street, Carlisle. Closing date: 12th July.
H. D. A. ROBERTSON,
Town Clerk.
1505

PONTARDAWE RURAL DISTRICT COUNCIL
ENGINEER AND SURVEYOR'S DEPARTMENT
Applications are invited for the following vacancies.
(a) HOUSING ASSISTANT—Salary Grade IV A.P. & T.D. (£710—£885). Applicants must have had extensive experience in Local Authority Housing including the preparation of final accounts.
(b) GENERAL ASSISTANT—Salary Grade II A.P. & T.D. (£595—£675). Applicants must have completed professional training and have had experience in Local Authority Housing.
The Council will assist in providing Housing Accommodation if required.
The appointments are subject to the Local Government Superannuation Act, 1933, and the successful candidate passing a medical examination.
Applications, stating age, education, previous experience and qualifications, together with the names of two referees, should be submitted to the undersigned before Monday, July 9th, 1956.
D. GLYN MEREDITH,
Clerk to the Council.
Council Offices,
Pontardawe, Glam.
19th June, 1956. 1537

DORSET COUNTY COUNCIL require ASSISTANT ARCHITECT (Scale £650×£30—£840 per annum).
Candidates must be A.R.I.B.A. and experience of Education buildings would be an advantage but not essential.
Application forms from the Clerk, County Hall, Dorchester, to be returned by 27th July, 1956.
1534

CITY OF BIRMINGHAM EDUCATION COMMITTEE
COLLEGE OF ART AND CRAFTS
BIRMINGHAM SCHOOL OF ARCHITECTURE
Principal:
Meredith W. Hawes, A.R.C.A., A.R.W.S., N.R.D.
Director of School of Architecture:
Douglas Jones, Dip.Arch (Liverpool), F.R.I.B.A.
Applications are invited from suitably qualified people for the appointment of a SENIOR LECTURER IN PLANNING, either on a full-time or part-time basis, to take charge of this new Section.
Salary will be in accordance with the Burnham (Further Education) Scale 1954 for Senior Lecturers (£1,065×£25—£1,215 per annum for a full-time appointment, or a proportional amount of this sum for a part-time appointment). The successful applicant will be required to take up duty in September next or as soon as possible thereafter.
Forms of application and further particulars of the post may be obtained from the Principal, College of Art and Crafts, Margaret Street, Birmingham, 3.
Closing date 10th July, 1956.
E. L. RUSSELL,
Chief Education Officer.
June, 1956. 1536

SURREY COUNTY COUNCIL
COUNTY PLANNING DEPARTMENT
Applications are invited for the following Headquarter's appointments at Kingston-upon-Thames:—
(a) ONE PLANNING ASSISTANT, Grade IV (£710×£35—£885), plus London allowance. Development Control.
(b) ONE DRAUGHTSMAN, Grade I (£530×£20—£610), plus London allowance.
Applications, stating age, experience, and qualifications, together with the names of two persons to whom reference may be made, should be lodged with the Clerk of the Council not later than 16th July, 1956.
County Hall, Kingston-upon-Thames. 1502

COUNTY BOROUGH OF NEWPORT
BOROUGH ARCHITECT'S DEPARTMENT
Applications are invited for the following permanent appointments:
(a) ASSISTANT ARCHITECTS. Grade 4 (£710—£885). Applicants must be Associate Members R.I.B.A.
(b) ARCHITECTURAL ASSISTANT, Grade 3 (£640—£765). Salary in Special Grade (£690—£840) if qualified by final examination R.I.B.A.
(c) BUILDING SURVEYOR. Grade 5 (£795—£970). Applicants must be Associate Members R.I.C.S.
(d) ASSISTANT QUANTITY SURVEYOR. Grade 2 (£595—£675).
(e) CLERKS OF WORKS. Grade 2 (£595—£675).
Housing accommodation will be provided for *a,b,c,d* if necessary.
Further particulars and application form from the Borough Architect, Civic Centre, Newport, Mon., to whom they should be returned not later than Monday, 16th July, 1956. 1538

COUNTY OF LEICESTER
(a) SENIOR ASSISTANT ARCHITECT—£795—£970.
(b) ASSISTANT ARCHITECTS—£690—£840.
(c) ARCHITECTURAL ASSISTANTS—£595—£675 or £640—£765.
Candidates for (a) must be registered architects experienced in the design of modern buildings and capable of carrying through large projects from inception to completion; for (b) must have passed Parts I and II of the R.I.B.A. Final; for (c) must be of intermediate standard with some experience. Apply on form obtainable from County Architect, 123, London Road, Leicester.
1535

KENT COUNTY COUNCIL
Appointments for work on the Council's extensive Education Building Programme are open to Architects able to accept responsibility and display initiative within a group system. Ability for progressive thought on current design and cost problems an advantage.
Candidates must be Associates of the R.I.B.A. Salary within scale £795—£970. N.J.C. conditions of service. Application forms from the County Architect, Springfield, Maidstone. Closing date 25th July, 1956. 1543

BOROUGH OF DEAL
BOROUGH ENGINEER'S DEPARTMENT
Applications are invited for the following appointments:—
(a) ASSISTANT ENGINEER, Grade A.P.T. III (£640—£765).
(b) ASSISTANT ARCHITECT, Grade A.P.T. II (£595—£675).
Applicants for either post must have passed the Intermediate Examination of an appropriate professional institution and have practical experience in the work of a municipal authority.
The appointments are subject to one month's notice on either side, and to the provision of the Local Government Superannuation Acts.
The Council will be prepared to assist with housing accommodation if necessary.
Applications with names of three referees should be sent to the Borough Engineer, Municipal Offices, Deal, not later than 13th July, 1956.
E. S. DIXON,
Town Clerk.
Municipal Offices,
Queen Street,
Deal. 1542

CRICKLADE AND WOOTTON BASSETT RURAL DISTRICT COUNCIL
APPOINTMENT OF ENGINEERING AND SURVEYING ASSISTANT
Applications are invited for the appointment of ENGINEERING and SURVEYING ASSISTANT to the Engineer and Surveyor, Mr. J. C. Grindley, A.M.I.C.E., A.R.I.C.S., M.I.Mun.E., A.M.T.P.I., at a salary in accordance with the Special Grade of the National Conditions of Service (£690 × £30 to £840 per annum).
The appointment will be subject to the provisions of The Local Government Superannuation Act, 1937, and to the successful candidate passing a medical examination.
Preference will be given to applicants who have had experience in housing works.
Applications, endorsed "Engineering and Surveying Assistant," stating age, qualifications and experience, together with copies of not more than three recent testimonials, should reach the undersigned, not later than Tuesday, the 24th July, 1956.
W. J. HOSIER,
Clerk of the Council.
Council Offices,
Manor House,
Wootton Bassett,
Wilts.
25th June, 1956. 1545

PONTYPRIDD URBAN DISTRICT COUNCIL
APPOINTMENT OF ARCHITECTURAL ASSISTANT
APPLICATIONS are invited for the appointment of ARCHITECTURAL ASSISTANT at a salary in accordance with the maximum of the A.P.T. Division, Grade IV, £885 per annum.
Candidates must be Associate Members of the Royal Institute of British Architects.
The appointment is subject to the provisions of the Local Government Superannuation Act, 1937, a satisfactory medical examination and one month's notice on either side for termination.
Housing accommodation (if required) will be provided.
Form of application and further particulars may be obtained from Mr. W. Cecil Evans, Architect and Surveyor, Municipal Buildings, Pontypridd.
Applications must be delivered to the undersigned not later than Saturday, the 14th July, 1956.
BERNARD M. MURPHY,
Clerk of the Council.
Municipal Buildings,
Pontypridd.
23rd June, 1956. 1544

WEST SUSSEX COUNTY COUNCIL
COUNTY ARCHITECT'S DEPARTMENT
Applications are invited for the following appointment:—
ASSISTANT STRUCTURAL ENGINEER, at a salary in accordance with A.P.T. Grade VI (£880 to £1,080). Commencing salary according to experience.
Further particulars should be obtained from the County Architect, County Hall, Chichester, to whom detailed applications must be submitted not later than the 25th July, 1956.
T. C. HAYWARD,
Clerk of the County Council.
County Hall, Chichester.
28th May, 1956. 1503

LONDON COUNTY COUNCIL
BRIXTON SCHOOL OF BUILDING, September, 1956. Part-time day and evening LECTURERS in Building Construction and allied subjects and History of Architecture for classes in Dept. of Architecture and Surveying. Should possess appropriate professional qualifications. Applications to Secretary at School, Ferndale Road, S.W.4. (1198) 1467

SALOP COUNTY COUNCIL
Applications are invited for appointment of PLANNING ASSISTANT, Grade II (£595—£675 per annum). Applicants should have passed the Intermediate Examination of the Town Planning Institute or its equivalent, and have had experience in a Planning Office. Post is subject to N.J.C. conditions and is pensionable.
Applications, giving full particulars and names of two referees, to County Planning Officer, County Buildings, Shrewsbury, by 5th July, 1956. Canvassing disqualifies.
G. C. GODBER,
Clerk of the County Council.
1474

VACANCIES for ARCHITECTURAL and TOPOGRAPHICAL MODEL MAKERS (up to £817 per annum). Previous experience essential, and applicants should be able to work from architects' plans and elevations on wood, card, metal and perspex.
Application form, returnable by 18th July, 1956, from Architect (AR/EK/MM/5), London County Council, The County Hall, S.E.1. (1233). 1539

LONDON COUNTY COUNCIL
ARCHITECT'S DEPARTMENT
Vacancies exist for ARCHITECTS GRADE I (salaries in the range £1,184 to £1,353) to lead groups in the housing, Schools and General Divisions. Applicants should be good designers with experience in controlling staff and organising and supervising large scale building contracts. A.R.I.B.A. or R.I.B.A. Final Exam. required. Particulars and application form, returnable by 18th July, 1956, from the Architect (AR/EK/HSG/1), County Hall, S.E.1. (1282) 1540

POPLAR BOROUGH COUNCIL invite applications from suitably qualified candidates for temporary appointment of ARCHITECTURAL ASSISTANT, A.P.T. III (£640—£765), plus £30 per annum and London weighting. Application forms obtainable from Borough Engineer and Surveyor, Poplar Town Hall, Bow Road, E.3. Closing date: 16th July, 1956. 1527

Architectural Appointments Vacant

4 lines or under, 7s. 6d.; each additional line, 2s.

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